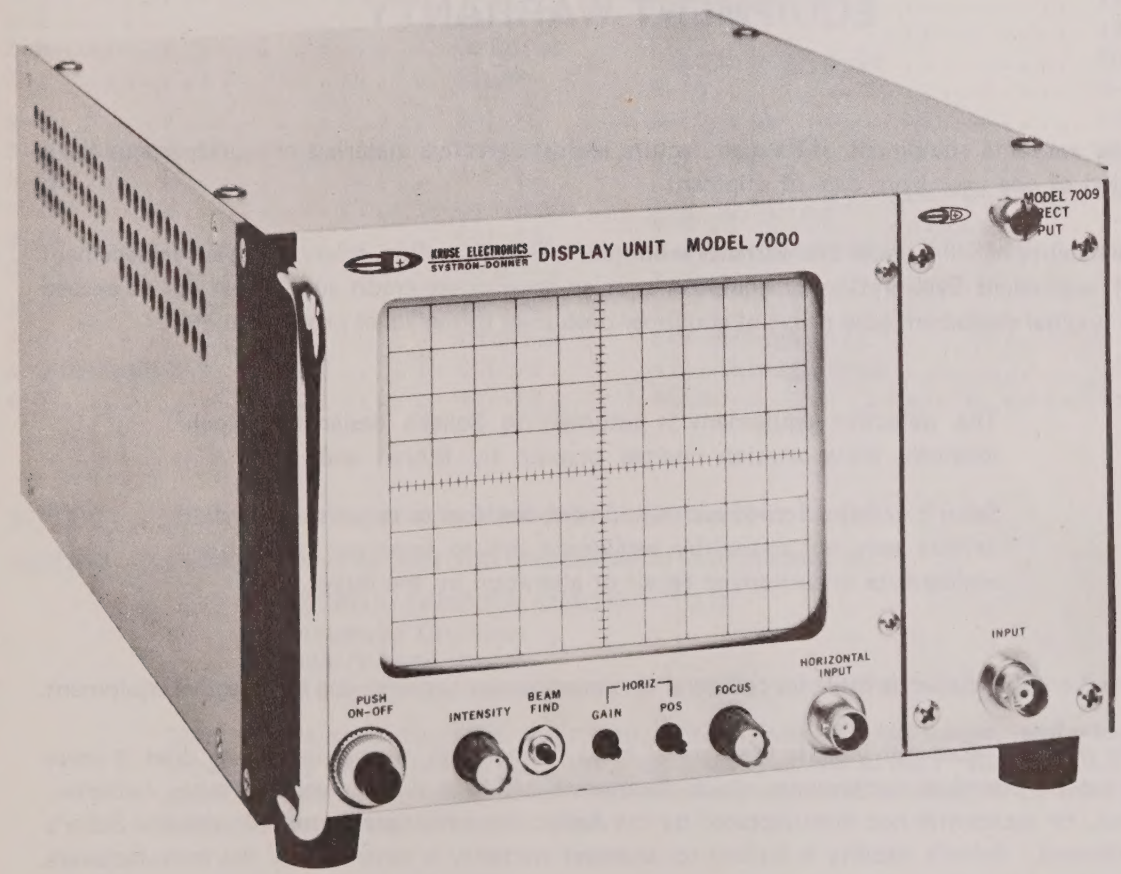
SYSTRON DONNER

OPERATION AND SERVICE MANUAL



MODEL 7000

DISPLAY UNIT

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SYSTRON DONNER CORPORATION
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CONCORD, CALIFORNIA 94518 USA

MICROWAVE DIVISION
SYSTRON DONNER CORPORATION

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SYSTRON DONNER

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NOTE 1) All Original pages are dated 9-1-71 (September 1, 1971)

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SECTION 1

INTRODUCTION AND DESCRIPTION

1.1 SCOPE OF MANUAL

This manual provides application information, operating instructions, theory of operation, and maintenance instructions for the Systron-Donner Microwave Division Model 7000 Display Unit. Similar information for the plug-in amplifiers is contained in manuals supplied with these units.

1.2 DESCRIPTION

The Model 7000 Display Unit is composed of a cathode ray tube (CRT) display with calibrated 8 by 10 centimeter graticule, X, Y, and Z axis amplifiers, power supplies, and plug-in compartment for a 7000-series amplifier.

The Display Unit is completely solid-state with the exception of a beam-finder relay and the flat-faced CRT used as the visual readout device. This construction assures long-term reliability of the instrument and unlimited life, with years of maintenance-free service.

Calibration of the 7000 is fast and simple; there are only three internal adjustments. Silicon semiconductors, precision wirewound and metal film resistors, and plug-in glass epoxy circuit boards are used. Generally, precision part values are selected at the time of manufacture to ensure optimum performance, rather than relying on variable components.

1.3 APPLICATIONS

Specifically designed for use with the Systron-Donner 5000A and 540B sweepers or the 50525 Multiband Sweep System, the 7000 Display Unit may also be used with any other sweeper or network analyzer for measurement and display of VSWR or reflection coefficient, amplifier response and gain, filter attenuation and bandpass, and spurious signal content.

In fact, the 7000 can be used anywhere an X-Y or X-Y-Z display is needed. Many kinds of test setups could be assembled using the 7000 Display rather than a general-purpose laboratory oscilloscope, thereby freeing the much more expensive lab scope for use in measurements requiring its increased capabilities.

In addition, the 7000 Display with its plug-in amplifiers offers versatility never found before in an X-Y display unit. The logarithmic plug-in is particularly useful in RF measurements; when used with a square-law detector, the display is read directly in RF power ratio expressed in decibels (dB).

1.4 PLUG-IN VERTICAL AMPLIFIERS

Model 7009 Direct Input Plug-in. A passive plug-in, this unit is used where the basic 7000 vertical sensitivity of 1 V/division is sufficient, or when a customer wishes to build a special plug-in. When a Model 7100 Data Normalizer is used, the active plug-in is generally used in the 7100 and the passive plug-in is used in the 7000.

Model 7010 Linear Amplifier. This linear amplifier plug-in provides calibrated, stable displays with sensitivity from 100 μV/division to 1 V/division. The 7010 is especially well suited for use in test setups with linear crystal detectors. AC/DC input selection and offset control simplify measurements of small signals riding on large signals, such as passband transmission ripple. Frequency response is switchable from DC to 30 or 300 kHz (DC) or 1 Hz to 30 or 300 kHz (AC).

Model 7010-M1 Linear Amplifier. Similar to the 7010, this unit offers 100 μV to 1 V/division sensitivity and a high impedance (1 MΩ) floating difference input. The front-panel markings include dB/division calibrations for use with the S-D 4020-series Digital Power Meters.

Model 7011 Logarithmic Amplifier. The 7011 logarithmic plug-in provides calibrated, stable displays read directly in voltage ratio expressed as dB (.01 dB/division to 20 dB/division for a linear detector). This voltage range is equivalent to RF power levels of .005 dB/division to 10 dB/division when using a square-law detector. Offset is adjustable from zero to 100 dB (voltage) or zero to 50 dB (RF power).

1.5 OPTIONS

Option M1: Adds a REMOTE INPUT connector to the rear panel, allowing remote connection to the 7000 marker, blanking, and horizontal inputs in addition to the normal rear-panel BNC connectors. The CRT graticule is still 8 x 10 centimeters, but is marked in 10 x 10 divisions.

1.6 ACCESSORIES

Rack Adapter Model 9016. This unit fits a standard 19-inch rack and allows two Model 7000 displays or one 7000 and one 5000A sweeper to be mounted in 5-1/4 inches of rack space.

Stack Adapter Model 9005. This unit is used to firmly connect one 7000 display to the top of a 5000A sweeper.

Dummy Load Model 9204. This unit plugs into the 7000 in place of a vertical amplifier, and is used when testing and adjusting the 7000 power supplies.

Extender Model 9205. When inserted between the 7000 interface connector and vertical plug-in, this unit allows easy access to the plug-in for testing or repair.

Plug-in Inverter Model 9206. The 9206 is used during servicing to invert the plug-in without turning the 7000 upside down.

Camera Bezel Kit Model 9034. The camera bezel is designed for mounting Hewlett-Packard 195A, 197A, and 198A oscillographic recording cameras to the Model 7000. Included in the field-installable kit are modified 7000 control knobs and a graticule which glows under ultraviolet radiation (as supplied by Hewlett-Packard 197A and 198A cameras).

1.7 SPECIFICATIONS

DISPLAY SIZE	
Vertical	8 cm
Horizontal	10 cm
VERTICAL AMPLIFIER	
Main Vertical Input (from Plug-in)	
Sensitivity	1 V/Div
Risetime	1 μs max
Frequency Response	DC to 300 kHz
Input Impedance	50 kΩ min
Auxiliary Vertical Input (Rear Panel)	
Sensitivity	2 V/Div
Risetime	1 μs max
Frequency Response	DC to 300 kHz
Input Impedance	100 kΩ min
Vertical Output	
Level	1 V/Div
Impedance	1 kΩ nom
HORIZONTAL AMPLIFIER	
Sensitivity	0.8 to 2 V/Div, variable by front-panel control
Risetime	5 μs max
Frequency Response	DC to 100 kHz

HORIZONTAL AMPLIFIER (Cont.)	
Input Impedance	20 kΩ min
Position Control Range	±10 Div
BLANKING	
Sensitivity	2 V to blank trace from normal intensity
	8 V to blank trace from full intensity
Polarity	+ or - , switch-selected
Input Impedance	5 kΩ min
MARKER	
Sensitivity	2 V to intensify trace from normal intensity
	8 V to intensify trace from zero intensity
Polarity	+ or - , switch-selected
Input Impedance	5 kΩ min
BEAM FINDER RANGE	Pressing switch causes trace to be displayed on screen, regardless of intensity, gain, or position control settings
CATHODE RAY TUBE CIRCUIT	
Type	8 x 10 cm flat face; electrostatic focus and deflection
Phosphor	P2, medium persistence blue-green
Accelerating Potential	2,350 V nom
POWER INPUT	
Voltage	115 or 230 V ±10%, switch-selected
Frequency	50 to 400 Hz
Total Power	80 VA max
PHYSICAL	
Dimensions	5-1/4" H x 8-1/2" W x 14" D (13.34 cm H x 21.6 cm W x 35.6 cm D)
Type	Half-rack size
Weight	14 lbs (6.35 kg) max

ENVIRONMENT	
Temperature	
Ambient	-55 to +85° C (-67 to +185° F)
Operating	0 to +55° C (+32 to +131° F)
Altitude	10,000 feet (3.05 km) maximum

1.8 SPECIFICATIONS FOR AMPLIFIER PLUG-INS

Abbreviated specifications for the amplifier plug-ins are listed below. These specifications are for information only, and may be superseded by published specifications in the appropriate instruction manual or in the Systron-Donner catalog.

Model 7010 Plug-in

INPUT	
Sensitivity	100 μV/Div to 1 V/Div calibrated in 1-2-5 sequence and with x10 gain switch. Vernier control reduces gain to ≈ 1/3 of calibrated setting. Switch selects input polarity
Impedance	100 kΩ, shunted by 5 pF
RESPONSE	
DC Coupled	0 to 300 kHz; switch reduces upper limit to 30 kHz
AC Coupled	1 Hz to 300 kHz; switch reduces upper limit to 30 kHz
INPUT	100 kΩ, shunted by 5 pF. Maximum input 100 V, peak
NOISE	500 μV p-p maximum referred to input at 300 kHz bandwidth; 20 μV p-p maximum at 30 kHz
DC OFFSET	±200 mV minimum on 100 μV/Div setting; offset voltage increases with attenuator setting. 10-turn control

Model 7010 M1 Plug-in

INPUT	
Sensitivity	1 mV/Div to 1 V/Div in 1-2-5 sequence; range can be changed to 100 μV/Div to 100 mV/Div with front-panel switch. .01 dB/Div to 10 dB/Div in 1-2-5 sequence (can be changed to .001 dB/Div to 1 dB/Div with front-panel switch) when used with 4020-series Power Meters.
Impedance	1 MΩ, shunted by 14 pF

RESPONSE	
DC Coupled	0 to 50 kHz; switch reduces upper limit to 30 kHz
AC Coupled	1 Hz to 50 kHz; switch reduces upper limit to 30 kHz
INPUT	1 MΩ, shunted by 14 pF. Maximum input 100 V, peak
NOISE	550 μV p-p maximum referred to input at 50 kHz; 500 μV maximum at 30 kHz
DC OFFSET	±10 mV minimum on 100 μV/Div setting; offset voltage increases with attenuator setting. Screwdriver-adjust potentiometer.

Model 7011 Plug-in

INPUT	
Sensitivity	0.02 dB/Div to 20 dB/Div in 2-4-10 sequence referred to input voltage, or 0.01 dB/Div to 10 dB/Div in 1-2-5 sequence for square-law detectors
Impedance	50 kΩ, shunted by 10 pF
Level	100 μV to 10 V, referred to input voltage
Polarity	+ or -
DYNAMIC RANGE	50 dB square-law detector range: 100 dB referred to input voltage
ACCURACY	< ±.01 dB/dB indicated at 25° C
RESPONSE SPEED	From < 200 μs at 100 μV to < 1 μs above 100 mV, referred to input voltage
DC OFFSET	Calibrated in dB. Allows trace to be adjusted to zero for any input over a 100-dB range referred to input voltage and a 50-dB range for square-law detectors.
INPUT OFFSET	Front-panel CAL control allows units to be balanced for use in test setups where differing ground potentials exist.

SECTION 2

INITIAL INSTRUCTIONS

2.1 UNPACKING AND INSPECTION

The instrument is shipped in a specially constructed container to provide maximum protection to the equipment during transit. Use care when unpacking to prevent damage to the equipment, such as cabinet finish, controls, indicators, connectors, etc.

Removing Contents. To remove the instrument from the shipping container, cut and fold back outer carton top flaps, remove top protective cushion, lift instrument clear from shipping container, open dust protection bag and remove equipment.

Inspection. The instrument was carefully tested and inspected prior to shipment. Inspect the instrument for damage incurred during shipment. Check that the power cable is supplied with the instrument. If the instrument is damaged in any way, see the warranty and repair notices at the front of this manual.

2.2 PREPARATION FOR USE

The instrument is shipped ready for use. Required power source is 115 or 230 volts AC ± 10%, single phase, at approximately 80 watts. The instrument is normally shipped with the 115/230 V switch in the 115 V position. For operation from 230 volts, follow the directions below:

a. Be sure the power cord is disconnected.

b. With a small screwdriver, move the 115/230 V switch on the rear panel to the 230 V position.

c. Remove the 1A fuse on the rear panel and replace it with a 3AG, 0.5A, slow-blowing fuse.

d. Do not connect the power cord between the LINE connector and power source until instructed to do so in Paragraph 3.3.

This instrument is equipped with a three-conductor power cable which, when plugged into an appropriate receptacle, grounds the instrument for safety. The offset center pin of the rear panel three-prong LINE connector is the ground pin. It is recommended that the instrument be grounded to protect operating personnel. To preserve the protective feature of the instrument when operating from a two-contact outlet, use a two-prong adapter with the ground wire connected to a convenient ground point.

2.3 MOUNTING

Bench Use. The display is normally supplied with rubber feet and a fold-away tilt stand for convenient bench operation. The tilt stand permits raising the front of the instrument so that the display and control markings can be seen easily.

Rack Mounting. To rack mount the display, necessary hardware including joining plates and corner brackets with handles are available as Model 9016. Instructions for rack mounting are provided with the hardware kit.

Stack Mounting. To mount the display on top of a Model 5000A Sweeper, the hardware supplied in Model 9005 must be used. Instructions are provided in the hardware kit.

2.4 PACKAGING FOR SHIPMENT

If the instrument is to be packaged for shipment, use the original shipping container and packaging (see Figure 2.1). If the original material has been discarded or is not in condition for re-use, perform the following packaging procedure:

a. Wrap the instrument in a heavy wrapping or plastic protective covering.

b. Place a protection cushion in the botton of shipping carton and place the instrument on the protective cushion.

c. Surround the remaining sides and top with additional protective cushions. Place front and rear protective cushions in such a manner as to provide support of the instrument without resting it on controls or connectors.

2.5 SHIPPING METHOD

This instrument should be shipped only by truck freight, rail freight, air freight, or parcel delivery service. If it is shipped by parcel post, damage is likely to occur. Systron-Donner is not responsible for units damaged in shipment to the factory for repair, whether such units are in warranty or not.

2.6 INSURANCE

Insure the unit for full value whenever it is shipped.

2.7 RETURNS FOR REPAIR

Be sure to fully identify any instrument that is returned to Systron-Donner for repair of any kind, in-warranty or not. The paperwork with the unit must show the instrument serial number, malfunction or problem to be corrected, and the exact address to which the instrument should be returned when repairs are completed.

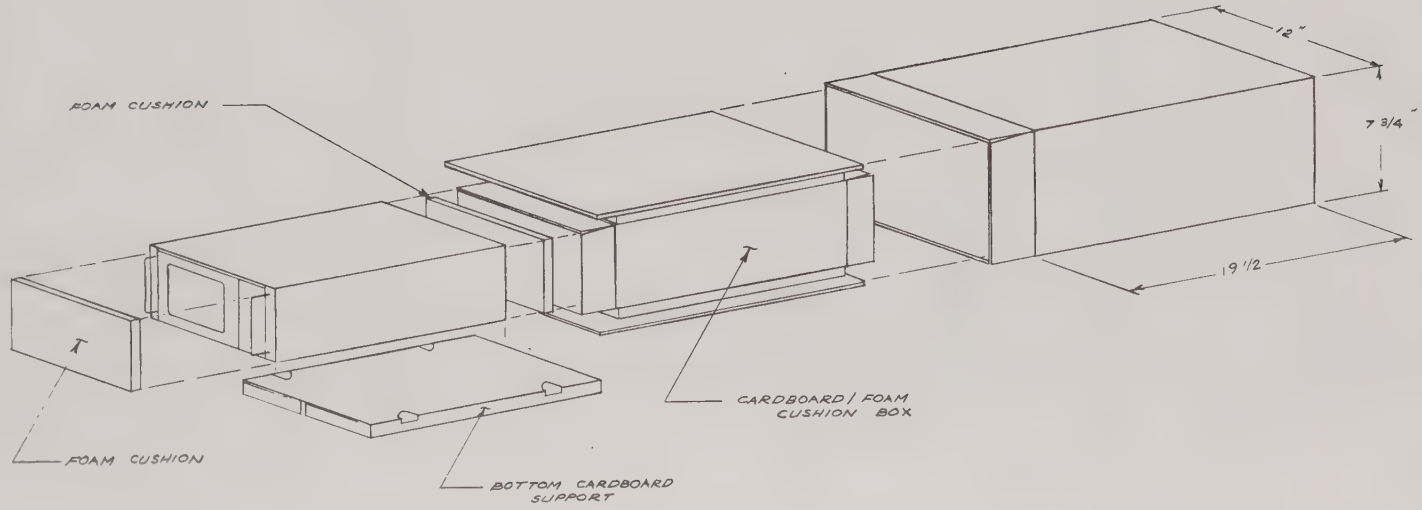


Figure 2.1 Packaging for Shipment

SECTION 3

OPERATION

3.1 GENERAL

This section contains instructions for operation of the Model 7000 Display Unit, but does not contain specific operating information for the plug-in amplifiers; these units have their own manuals.

CAUTION

TO AVOID POSSIBLE PERSONAL INJURY OR DAMAGE TO THE INSTRUMENT, DO NOT ATTEMPT TO OPERATE THE UNIT UNTIL YOU HAVE READ THIS SECTION.

3.2 CONTROLS, INDICATORS, AND CONNECTORS

The various controls, indicators, and connectors on the front and rear panels are shown in Figures 3.1 and 3.2, and described in Tables 3.1 and 3.2.

Table 3.1 Front Panel Controls, Indicators, and Connectors

FIGURE 3.1 INDEX	ITEM	FUNCTION
1	PUSH ON-OFF Switch and Indicator	Red alternate-action switchbutton. Controls AC power input to Display Unit; illuminates red to indicate that power is on.
2	Cathode Ray Tube	Blue/green phosphor CRT. Applied signals are displayed on the face of the CRT in the form of a trace; voltage represented on the horizontal (X) axis is plotted against voltage represented on the vertical (Y) axis.

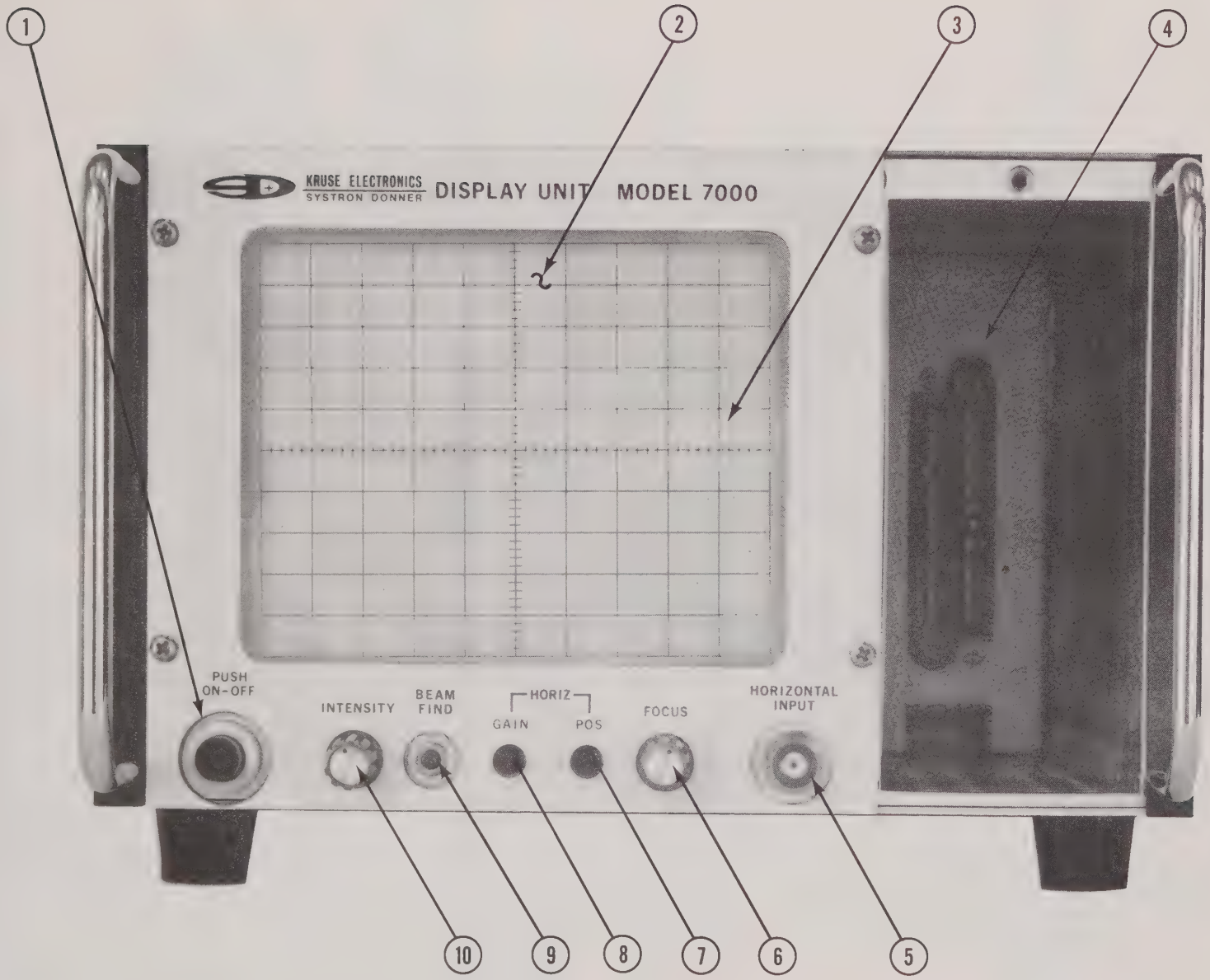


Figure 3.1 Front Panel Controls, Indicators, and Connectors

FIGURE 3.1 INDEX	ITEM	FUNCTION
3	Graticule	Plastic 8 x 10 cm graticule. This graticule has 8 major vertical and 10 major horizontal divisions; each major division has 5 minor subdivisions.
4	Plug-In Amplifier Connector	24-pin connector. Provides all power and signal connections between 7000 Display Unit and plug-in.
	WARNING THIS CONNECTOR CARRIES LETHAL VOLTAGES	
5	HORIZONTAL INPUT Connector	BNC connector. Accepts horizontal sweep input from an external source (such as the Model 5000A Sweeper) to provide deflection of the trace on the CRT horizontal (X) axis. This connector is in parallel with the rear panel horizontal input connector; either one may be used.
	CAUTION TO AVOID DAMAGE TO THE CRT, REDUCE BEAM INTENSITY WHEN THERE IS NO HORIZONTAL INPUT.	
6	FOCUS Control	Red knob and potentiometer. Controls voltage on CRT focusing grid. Adjust this control for the sharpest trace.
7	HORIZontal POSition Control	This control is used to center the trace on the horizontal (X) axis.

FIGURE 3.1 INDEX	ITEM	FUNCTION
8	HORIZontal GAIN Control	This control is used to adjust the horizontal input level; it should be adjusted so a complete sweep just fills the 10 div horizontal (X) axis graticule marking.
9	BEAM FIND Switch	Red momentary-action pushbutton switch. This control is used to locate the trace when it is deflected off-screen in any direction, or when the beam intensity is set too low to be seen. The trace will appear in the quadrant to which the trace has been deflected.
10	INTENSITY Control	Red knob and potentiometer. Controls the intensity (brightness) of the trace by controlling the CRT electron beam current. This control should normally be set for the minimum trace intensity that allows convenient viewing.

NOTE

The setting of this control determines the voltages required for blanking and markers.

CAUTION

TO AVOID DAMAGE TO THE CRT, REDUCE BEAM INTENSITY WHEN THERE IS NO HORIZONTAL INPUT.

Table 3.2 Rear Panel Controls and Connectors

FIGURE 3.2 INDEX	ITEM	FUNCTION
1	REMOTE INPUT Connector	5-pin connector (present only when Option M1 has been ordered). This connector parallels items 3, 6, and 7.
2	VERTICAL INPUT Connector	BNC Connector. Accepts vertical (Y axis) deflection voltage at a sensitivity of 2 V/ div.
	NOTE Do not use this connector if the Display Unit has a 7000 series amplifier plug-in installed(except for video bypass markers.)	
3	HORIZONTAL INPUT Connector	BNC connector. Accepts horizontal sweep input from an external source (such as the Model 5000A Sweeper) to provide deflection of the trace on the CRT horizontal (X) axis. This connector is in parallel with the front panel HORIZONTAL INPUT connector; either one may be used.
	CAUTION TO AVOID DAMAGE TO THE CRT, REDUCE BEAM INTENSITY WHEN THERE IS NO HORIZONTAL INPUT	
4	VERTICAL OUTPUT Connector	BNC connector. The output from a plug-in amplifier to the display unit vertical amplifier may be monitored at this point.

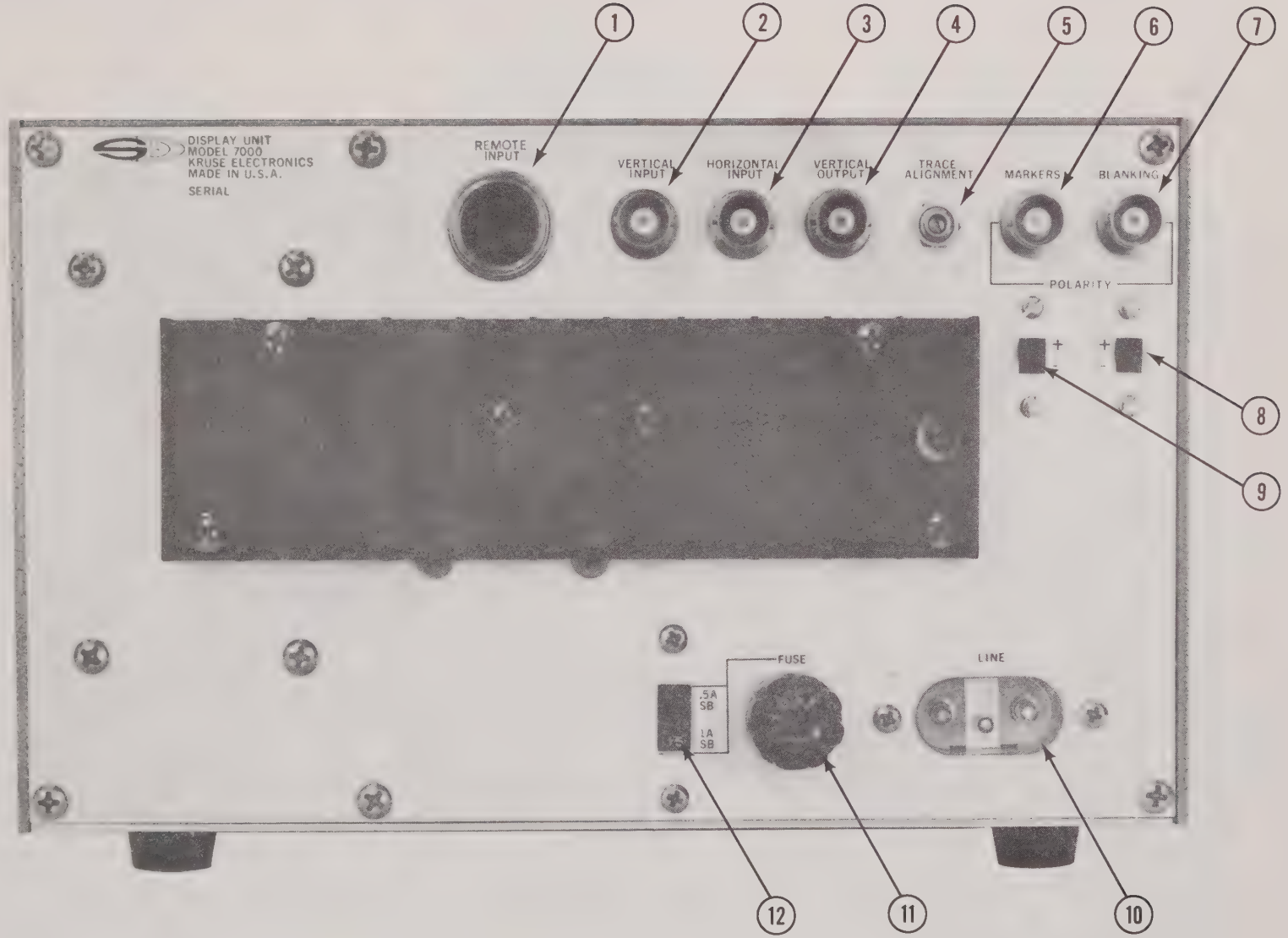


Figure 3.2 Rear Panel Controls and Connectors

5	TRACE ALIGNMENT Control	Screwdriver-adjusted potentiometer. This potentiometer controls the voltage to a deflection coil in the CRT magnetic shield; it is used to align the trace to true horizontal (with respect to the CRT graticule) by correcting the effects of magnetic fields or materials in any area in which a 7000 may be used.
6	MARKERS Connector	BNC connector. Accepts marker pulses from an external marker generator or sweeper (such as the Model 5000A) to brighten the CRT trace at pre-determined points. Refer to Paragraph 1.7 for marker voltage requirements.
7	BLANKING Connector	BNC connector. Accepts blanking pulses from an external source (such as the Model 5000A Sweeper) to blank out the trace at pre-determined times, such as the retrace (flyback) period. Refer to Paragraph 1.7 for blanking voltage requirements.
8	BLANKING POLARITY Switch	Slide switch. Sets the blanking circuitry to operate with + or - polarities from the BLANKING connector; also refer to Paragraph 1.7.
9	MARKERS POLARITY	Slide switch. Sets the marker circuitry to operate with + or - polarities from the MARKERS connector; also refer to Paragraph 1.7.
10	LINE Connector	Grounded 3-pin connector. Accepts input from power line through supplied power cord.

11	FUSE Holder	Black fuseholder. To remove fuse, push fuseholder cap in and rotate CCW. To install a fuse, insert the fuse in the cap, then push the cap into the fuseholder and rotate fully CW.

CAUTION

DO NOT REMOVE, CHANGE, OR INSTALL FUSES WITH THE POWER CORD CONNECTED TO A VOLTAGE SOURCE.

12	115/230 V Selector	Screwdriver-actuated slide switch. Sets voltage level at which Display Unit is to operate. To change voltage, unplug power connector, then move switch. Remove the fuse and replace it with a fuse of the value indicated by the position of the switch.

CAUTION

DO NOT CHANGE VOLTAGES WITH THE POWER CORD CONNECTED AND DO NOT FAIL TO CHANGE THE FUSE TO THE PROPER VALUE. SERIOUS DAMAGE TO THE INSTRUMENT COULD OCCUR IF THESE CAUTIONS ARE IGNORED.

3.3 OPERATING PROCEDURES

First Time Operating and Checkout Procedure. To operate the display unit for the first time, proceed in accordance with the following steps. If malfunctions are observed, refer to Section 5:

a. If applicable, install the unit in accordance with the rack adapter or stack adapter instruction sheets.

b. Determine the voltage and frequency available at the power outlet to which the 7000 is to be connected; it must be 115 or 230 V (± 10%) 50 to 400 Hz, 1 ϕ power.

c. Ensure that the 115/230 V switch on the rear panel is set to the correct position for the power available.

d. Remove the fuse by pushing in the fuseholder cap and turning it CCW.

e. Check the rating of the slow-blow fuse; make sure it is 0.5A for 230 V or 1.0A for 115 V operation.

f. Re-install the fuse (or install a new fuse) by inserting the fuse into the cap, then inserting the cap and fuse into the body of the fuseholder; push and turn CW.

g. Turn the front panel INTENSITY control fully CCW.

h. Install the plug-in in the plug-in compartment of the display unit; turn the small knurled knob at the top CW to lock in place.

i. Set the plug-in sensitivity switch to its least sensitive position.

j. Install the supplied power cord between the display unit and the power source.

k. Observe the PUSH ON-OFF indicator on the front panel; if it lights when the power cord is installed, the unit is on.

l. If the PUSH ON-OFF indicator is not lighted, press it in then release it; it should light.

m. The power is now on; watch and listen for any sounds of arcing or other evidence of malfunction.

n. After about 15 seconds, turn the INTENSITY control up until a dot or trace can be seen.

o. If no trace can be observed, press the BEAM FIND pushbutton. A dot will appear somewhere on the face of the CRT; if the dot is located more than 3 or 4 div to the left or right of the horizontal center of the graticule, adjust the HORIZ POS control. If the dot is located more than 3 or 4 div above or below the vertical center of the graticule, adjust the plug-in OFFSET control.

p. Release the BEAM FIND pushbutton; if the dot disappears, adjust the INTENSITY CONTROL.

q. Adjust the FOCUS control for a bright, sharp dot.

r. Decrease the INTENSITY control so that the dot is at the lowest intensity required for viewing. Re-adjust the FOCUS control.

s. Experiment with the HORIZ POS and OFFSET controls to observe their effect upon beam centering.

t. Connect appropriate horizontal, marker, and blanking signals to the HORIZONTAL INPUT, MARKERS, and BLANKING connectors through BNC-terminated cables. Do not connect a signal to the amplifier INPUT connector at this time. Refer to Paragraph 1.7 for the required signal levels.

u. Set the rear panel MARKERS and BLANKING POLARITY switches to match the input signal polarity.

v. Focus the trace to a sharp line; adjust the HORIZ GAIN and HORIZ POS controls so that the trace begins and ends at the left and right ends of the graticule.

w. With no signal connected to the vertical input, decrease the sweep speed until the CRT trace consists of a small dot moving slowly across the display. The dot must be of a uniform round shape, sharply focused across the entire face of the CRT. Any tendency of the dot to change shape is called astigmatism, and must be corrected by an internal adjustment (refer to Section 5).

x. Connect a vertical signal input to the plug-in INPUT connector, or to the rear VERTICAL INPUT connector if no plug-in is installed.

y. Observe the display to determine that it is of the proper amplitude and properly centered.

z. Determine that the markers are properly displayed as intensified dots on the trace; if they do not appear, check the amplitude and polarity of the signal source output and the setting of the rear panel POLARITY switch.

aa. In a like manner, determine that the blanking signal is being properly applied. Generally, this signal will eliminate the retrace as the trace moves from right to left across the screen.

ab. Operate the signal source (sweeper) in accordance with its instructions; observe the effect upon the trace of various sweeper control settings.

ac. This concludes the first time operation and checkout procedure for the Model 7000 Display Unit. Proceed to the first time operation and checkout procedure for the amplifier plug-in.

Use of Markers. Markers can be placed on the CRT trace in four different ways:

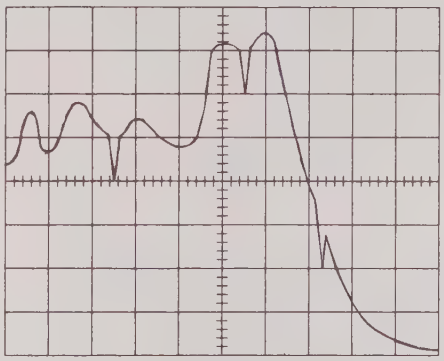
a. RF Dip Markers. By placing the 5000 plug-in MARKER switch in the "up" position or by selecting Model 521 INTEN markers, you can generate RF dip markers on the trace as shown in Figure 3.3, detail A. These markers are actually momentary dips in the RF level from the plug-in and show up only when the RF signal is detected. A cavity-type frequency meter inserted in the line from the 5000 plug-in will yield a single similar marker.

b. Intensity Markers. By connecting the rear-panel 5000A and 7000 MARKERS connectors together (and moving the 7000 MARKER POLARITY switch to -), you can make small intensified dots appear on the CRT trace, as shown in detail B of Figure 3.3. These markers are best seen if the INTENSITY control is kept low.

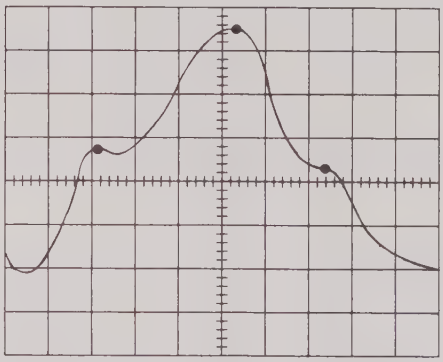
Intensity markers are also generated by the 540B Multiband Sweeper and the 50525 Multiband Sweep System. These intensity markers are not Z-axis (CRT cathode) markers but sweep-stop markers. When a marker point is reached, the sweep is stopped for a pre-determined period, then resumed. The extra time the CRT beam spends at these points results in intensified dots on the trace.

c. Video Bypass Markers. By connecting the rear-panel sweeper "markers" and 7000 VERTICAL INPUT connectors together, you can make dip markers as shown in detail C (Figure 3.3) appear on the trace. These are not RF dip markers, as in a, above, but are connected directly to the 7000 vertical axis amplifier. The sensitivity at this point is 2V/Div, and the marker output of the sweeper is more than 1V, so the markers will always cover a little over one-half division vertically. In cases where there is a large amount of attenuation in the RF circuits, these video bypass markers can often be more easily seen than RF dip markers.

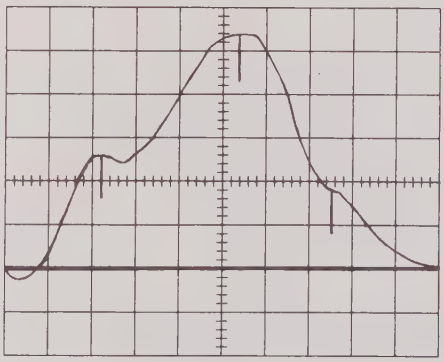
d. Combination Markers. RF dip markers can be used in conjunction with intensity markers; the result is an intensified dip as shown in detail D of Figure 3.3. To obtain these, connect the rear-panel sweeper and 7000 MARKERS connectors together, set the MARKER POLARITY switch on the 7000 to - , and the sweeper "markers" switch "on". Video bypass and intensity markers can be used together; use a BNC "T" connector and two cables to connect the 7000 VERTICAL INPUT and MARKERS connectors and the sweeper "markers" connector together.



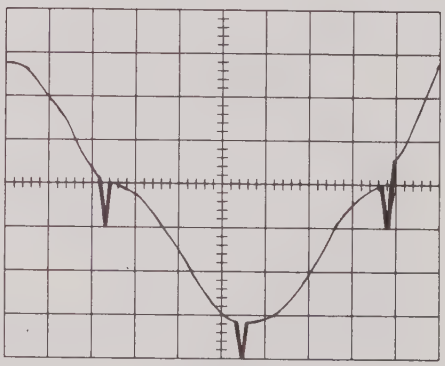
DETAIL A



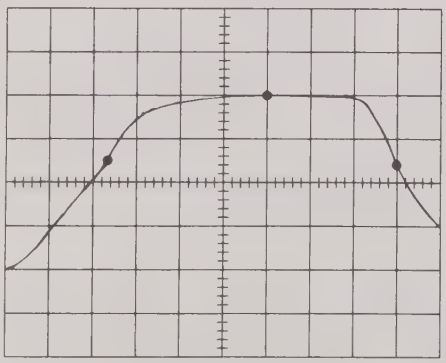
DETAIL B



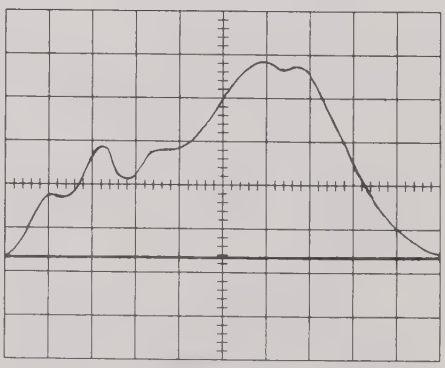
DETAIL C



DETAIL D



DETAIL E



DETAIL F

Figure 3.3 Representative Displays

Applications. Two typical uses of the 7000 Display are shown in Figures 3.4 and 3.5. Representative displays for test setups of this type are shown in Figure 3.3:

- Detail A. This display is typical of reflected power measurements over a fairly narrow band of frequencies. In this case, RF dip markers were used, as was blanking.

- Detail B. This display is typical of transfer characteristic measurements; the center frequency (shown with center marker) passes through the test unit with the least attenuation (or greatest amplification) while frequencies on the outer edges of the passband are attenuated. This trace shows intensity, or Z axis markers - the 5000A and 7000 MARKERS connectors are patched together, but the 5000 plug-in MARKERS switch is OFF. In addition, the BLANKING connectors of both units are patched together; note the lack of a retrace line.

- Detail C. Essentially similar to Detail B, this trace shows video bypass markers being used; the cable between the 5000A and 7000 BLANKING connectors was removed.

- Detail D. This trace shows the transfer characteristics of a band-rejection filter; the attenuation was greatest at the center frequency. Both RF dip and intensity markers were used i.e. the 5000 MARKERS switch was set to ON, and the MARKERS connectors were patched together.

- Detail E. This display shows the transfer characteristics of a device which has very flat frequency response between the marker frequencies. In this case, the 5000A MARKERS switch was OFF, but the MARKERS connectors were patched. Blanking was used.

- Detail F. Essentially similar to Detail A, no markers at all were used here, and the cable between BLANKING connectors was removed.

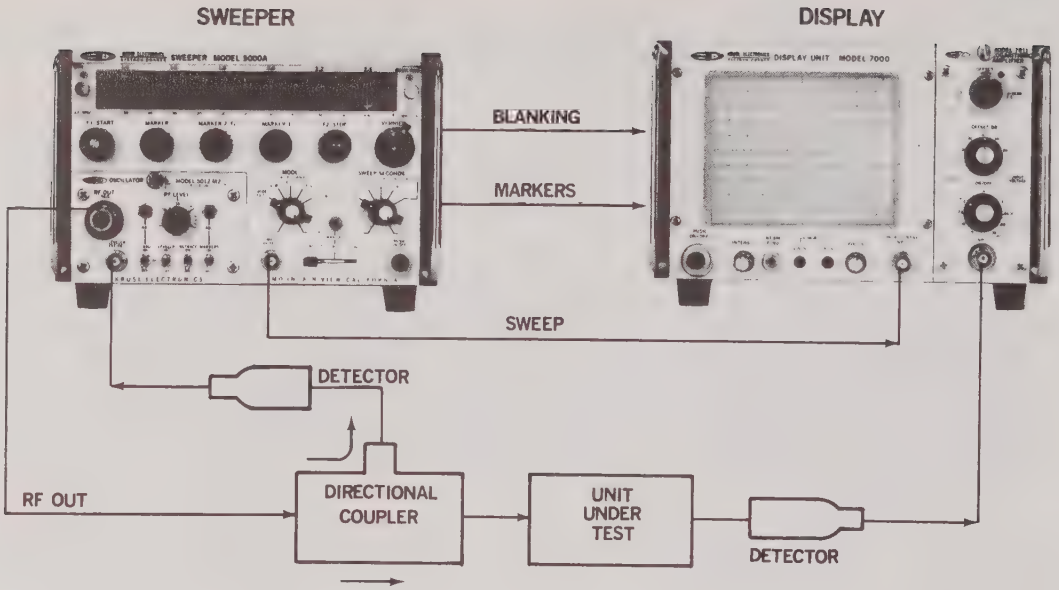


Figure 3.4 Typical Test Setup for Measurement of Transfer Characteristics

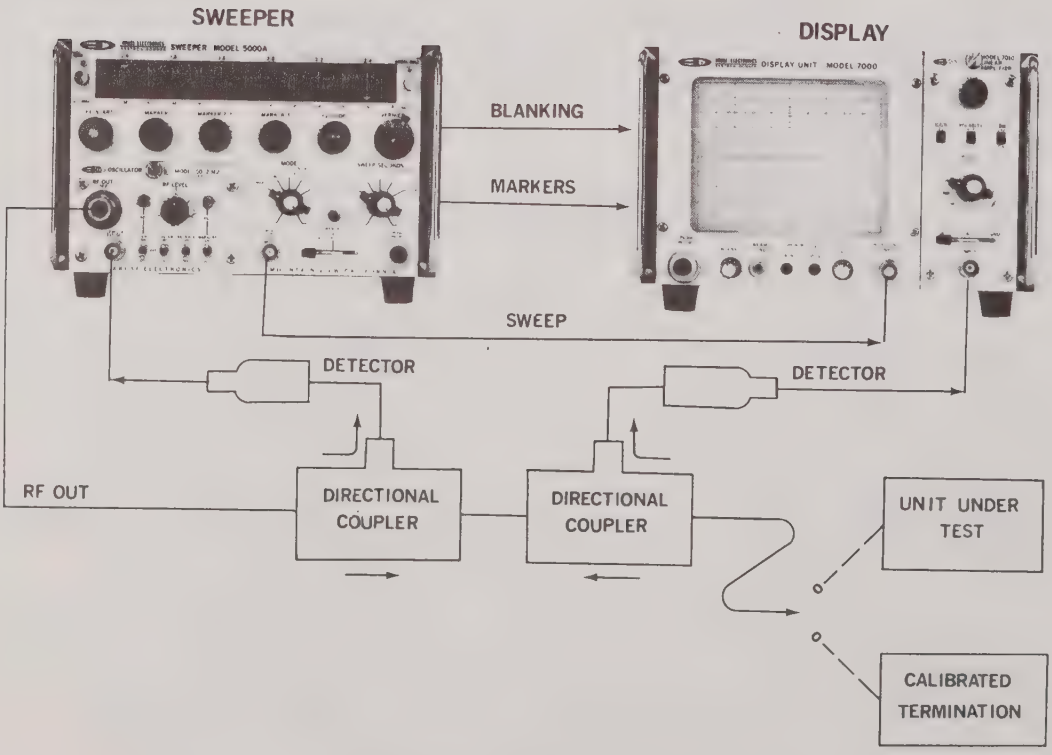


Figure 3.5 Typical Setup for Reflected Power and VSWR Measurements

SECTION 4

THEORY OF OPERATION

4.1 GENERAL

The Model 7000 Display Unit comprises a cathode ray tube (CRT) display device, five power supplies to convert the incoming line voltage to power levels required by the CRT and internal circuitry, deflection amplifiers to increase the vertical and horizontal input signals to usable levels, and intensity circuits to process blanking and marker inputs and control the CRT beam intensity. This section is divided into descriptions of those circuits in the following manner:

- Low/medium voltage power supplies and CRT circuits.
- High voltage power supply.
- Deflection amplifier circuits.
- Intensity circuits.

This section does not contain a description of the 7000 series plug-in amplifiers; these units have their own manuals.

4.2 LOW/MEDIUM VOLTAGE POWER SUPPLIES AND CRT CIRCUITS

The following description of the CRT filament supply, the +15 V, and - 15 V and +350 V power supplies and CRT control circuits is based upon block diagram Figure 4.1 and the schematic diagram in Section 6.

Incoming line voltage from LINE connector J10 is routed through fuse F1 to 115V/ 230V switch S5; when S5 is set to its 115V position, the two primary windings of power transformer T1 are connected in parallel. Moving the switch to 230V connects the windings in series.

CRT Filament Supply. One secondary winding of T1 supplies 6.3 V AC to power the filament of the CRT; this winding is heavily insulated from the other secondaries as it is elevated almost 3 kV from ground by the high voltage supply connected to the CRT cathode.

+15 V Supply. Two secondary windings of T1 carry 21 VAC; one of these is connected to the +15 V rectifier composed of diodes CR3 through CR6 in a full-wave bridge configuration. The rectified output is filtered by capacitor C1 and fed to series regulator transistor Q6; Q6 is controlled by driver Q1 and error amplifier Q17, described later. With the exception of the diode bridge, filter capacitor, and series regulator Q6, all other components are located on Deflection Amplifier board A3.

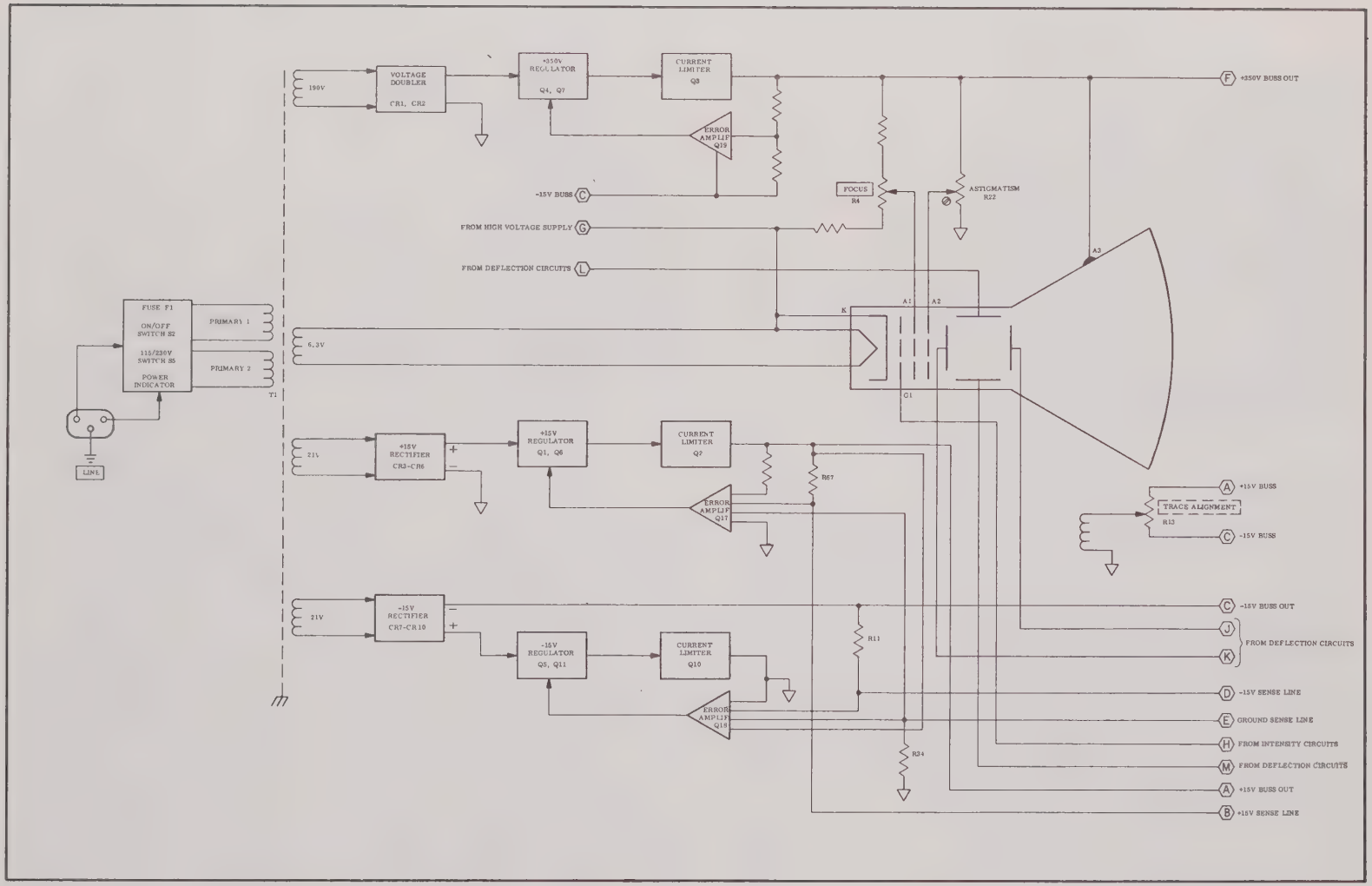


Figure 4.1 Low/Medium Voltage Power Supplies and CRT Circuits Functional Block Diagram

The output of Q6 is held constant at +15 V, and fed through current limiter Q2 to the +15 V bus; this bus is used to power the internal circuitry of the display unit and the plug-in amplifier.

Current limiter Q2 normally passes all current required by the display unit without interference; when current demands are heavy, as in the case of a short circuit or other malfunction, error amplifier Q17 will try to raise the voltage output of Q1 to any level necessary to supply those current demands. Without the short-circuit protection provided by the current limiter, this could cause destruction of the power supply in a fraction of a second.

The emitter and base voltages of Q2 normally differ by the voltage drop across series resistor R2, about 500 mV for a current of 1A. When the current through R2 reaches about 1.2A, the drop across it (and consequently the base-emitter voltage of Q2) is about 600 mV. This is the approximate point at which conduction of Q2 starts; this conduction reduces the base drive of driver Q1, and consequently of series regulator Q6. At about 2A, the voltage out to the +15 V bus will drop to zero.

The output of Q2 is sampled by error amplifier Q17, an integrated circuit operational amplifier; Q17 amplifies the difference (error) between the reference level and the output of Q2, and increases or decreases the base drive of Q1 (and consequently Q6) to compensate. The reference level is the 6.2 V across CR1, a very stable zener diode.

The output of Q2 is sensed at the plug-in connector; this results in a very high level of regulation for the plug-in. If there is no plug-in installed, the jumper that would normally connect the +15 V bus and the +15 sense line is replaced by 1 Ω resistor R67. This value is low enough to preserve regulation in the absence of the plug-in, but much higher than the short-circuit normally between the output and sense lines.

-15 V Supply. The -15V supply is essentially similar to the +15 V supply. The -15 V bus is taken directly from the negative output of full-wave bridge rectifier CR7-CR10. Regulation and current limiting is done in the line between the positive rectifier output and common (zero volts, or ground).

Both the + and -15 V supplies work against zero volts, which is a combined signal and power ground. This common line is also sensed at the plug-in connector and regulated. The -15 V power supply is referenced to the +15 V supply.

+350 V Supply. The fourth secondary winding of T1 supplies 190 VAC to voltage doubler CR1, CR2. The approximately +380 V output is fed through series regulator Q7 and current limiter Q3 to the +350 V bus. With the exception of the voltage doubler and series regulator Q7, all regulator components are located on Deflection Amplifier board A3.

Although the voltage levels are quite different, the operation of this supply is similar to that of the +15 V supply. The main differences are that the current demands are lower (so the base-emitter resistor of Q3 is a much higher value) and that the sensing is done locally. Any

difference between the output of Q3 and +350V is amplified by error amplifier Q19 and used to drive Q4, and consequently Q7, to correct this difference. The short-circuit current of this supply is about 40 mA. As with the -15V supply, the +350 V supply is referenced to +15V.

CRT Circuits. The CRT Circuits are connected as shown in Figure 4.1; the CRT accelerator anode (A3) is connected to the +350V bus and the cathode is connected to the -2 kV supply. This gives a potential of some 2,350V between A3 and cathode, enough for a bright trace under most ambient light conditions. Astigmatism control R22, an internal adjustment, adjusts the voltage on CRT anode 2 between zero and +350 V to give a trace of uniform size throughout the full deflection range.

The focusing circuit is connected between the +350V and - 2 kV; FOCUS control R4 selects any voltage between about -1 and 1.5 kV to be applied to focusing anode A1.

In operation, the hot filament of the CRT heats the cathode, causing it to emit electrons. The negatively-charged electrons are attracted by the positive voltages on grid 2, anode 2, and anode 3. The quantity of electrons allowed to leave the cathode is controlled by the voltage on grid 1 (refer to Paragraph 4.5). They are attracted and accelerated by anode A3. The stream of electrons is focused into a narrow beam by the charge on anode 1 and linearized by the charge on grid 2 and anode 2. Accelerator A3 is a graphite coating on the inside of the CRT envelope; the electrons are equally attracted by all sides of the CRT, and so travel straight toward the screen of the CRT.

This stream of electronics is deflected (bent) by any charges on the two vertical and two horizontal deflection plates. When the electrons hit the phosphor-coated screen of the CRT, they cause photons to be emitted, converting electron beam energy into light energy. The phosphor used is P2, medium persistence blue-green, and represents the best available compromise for high and low-speed display applications.

To compensate for any magnetic or electrostatic fields that may be present where the 7000 is used, a deflection coil is installed in the magnetic shield of the CRT. TRACE ALIGNMENT control R13 feeds the magnet winding any voltage between +15 and -15V, to compensate for tilt in either direction.

4.3 HIGH VOLTAGE POWER SUPPLY

The description of the high voltage (-2 kV) power supply is based upon block diagram Figure 4.2 and the schematic diagram in Section 6. The components referred to are located on High Voltage Power Supply board A1.

Power from the +15 and -15 V busses is decoupled by the π network filters consisting of L3-C14-C15 and L2-C12-C13 to prevent pulses or transients from feeding back to the rest of the circuitry in the 7000. The +15 V line is regulated by Q4 which is driven by error amplifier Q3, an operational amplifier. Q3 samples the voltage differential between the CRT cathode and ground, and drives Q4 to maintain a constant output voltage. Diodes CR11 and CR12 provide current limiting by turning off Q4 if the voltage drop across R15 exceeds 600 mV (300 mA through R15).

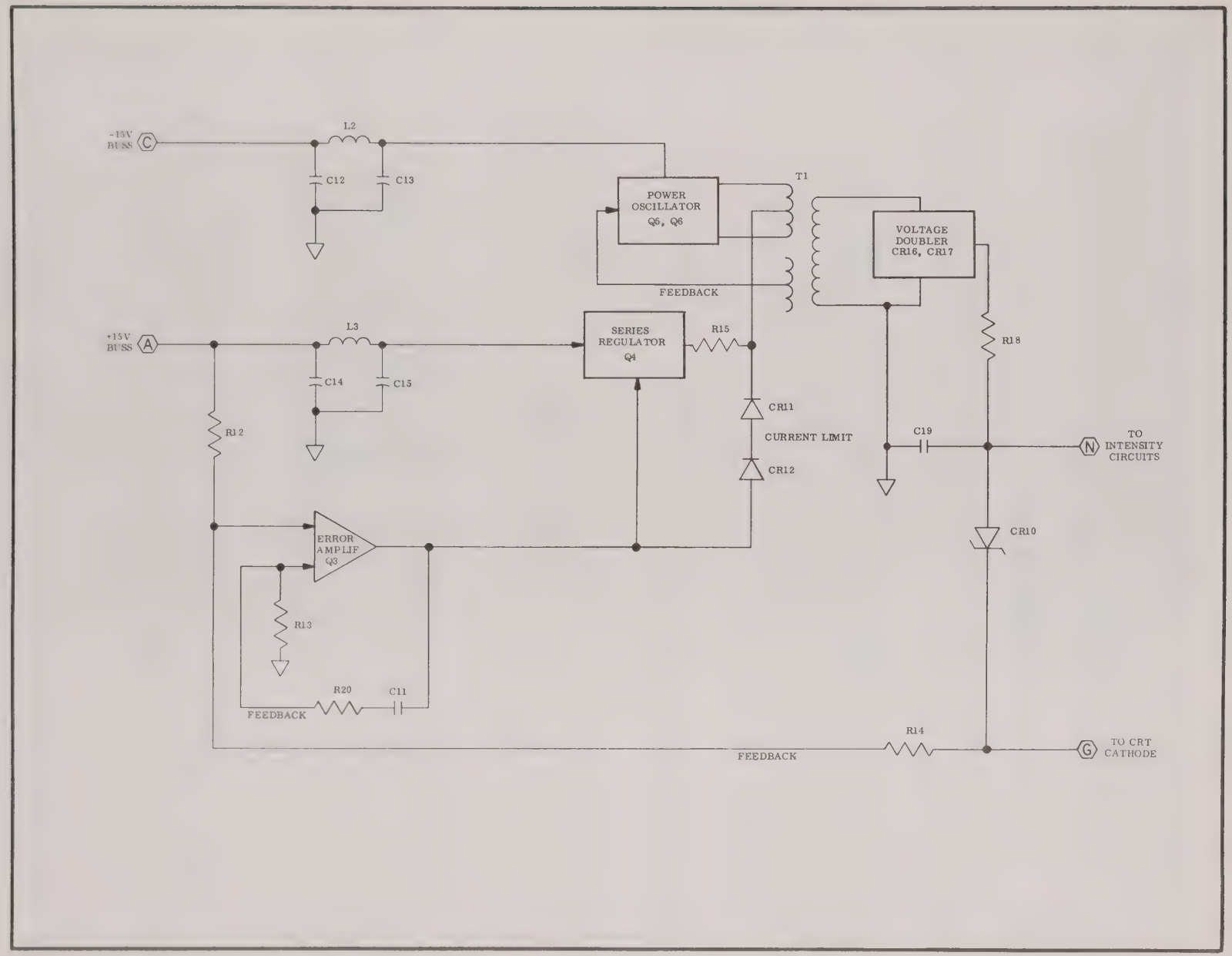


Figure 4.2 High Voltage Power Supply Functional Block Diagram

Q5, Q6 and T1 form a power oscillator, with feedback from a tertiary transformer winding. The secondary of T1 is connected to voltage doubler CR16, CR17. The output of about -2.5 kV is filtered by R18 and C19, and fed directly to the intensity circuits. This output is also fed through Zener diode CR10 (with a drop of 120 V) to the CRT cathode. This is the voltage that is sampled by Q3 and maintained constant by the on-board voltage regulator.

4.4 DEFLECTION AMPLIFIER CIRCUITS

The description of the deflection amplifier circuits is based upon block diagram Figure 4.3 and the schematic diagram in Section 6. All cited components except R1 and R2 are located on Deflection Amplifier board A3.

Horizontal Deflection Amplifier. Horizontal (sweep) input to the display unit can be made through the front or rear panel HORIZONTAL INPUT connector, pin 17 of the plug-in interface connector, or pin 4 of the REMOTE INPUT connector (M1 option only). The level of the input signal is controlled by variable resistor R1, HORIZ GAIN. The output of R1 is fed to sweep amplifiers Q14/Q15. The DC bias (and consequentlly the horizontal offset) is controlled by HORIZ POS control R2.

Positive-going portions of the input signal are amplified by Q14 and Q12; negative-going portions are amplified by Q15 and Q13.

Horizontal deflection plates D1 and D2 receive +350V through resistors R76 and R77. If there were no other connections to D1 and D2, no current would be drawn through R76 and R77, and there would be no voltage drop across them; +350V would be applied to both deflection plates, resulting in an undeflected dot centered horizontally on the CRT screen.

However, amplifiers Q14/Q12 and Q15/Q13 are also connected to the horizontal deflection plates, and draw a constant amount of current through R76 and R77, controlled by current sink Q16. With no signal input to Q14 and Q15, the same current is drawn through R76, Q12, Q14, and Q16 as is drawn through R77, Q13, Q15, and Q16. Again, this results in an undeflected dot centered horizontally on the CRT screen. When Q14 and Q15 are driven by horizontal input signals, the currents through R76 and R77 vary, but always total a constant amount.

When relay K1 is energized by the BEAM FIND switch, swamping resistors R46 and R47 are connected across the deflection plates, reducing the potential between them. This reduces the available voltage swing, and brings the trace onto the CRT screen regardless of the settings of the HORIZ GAIN and HORIZ POS controls.

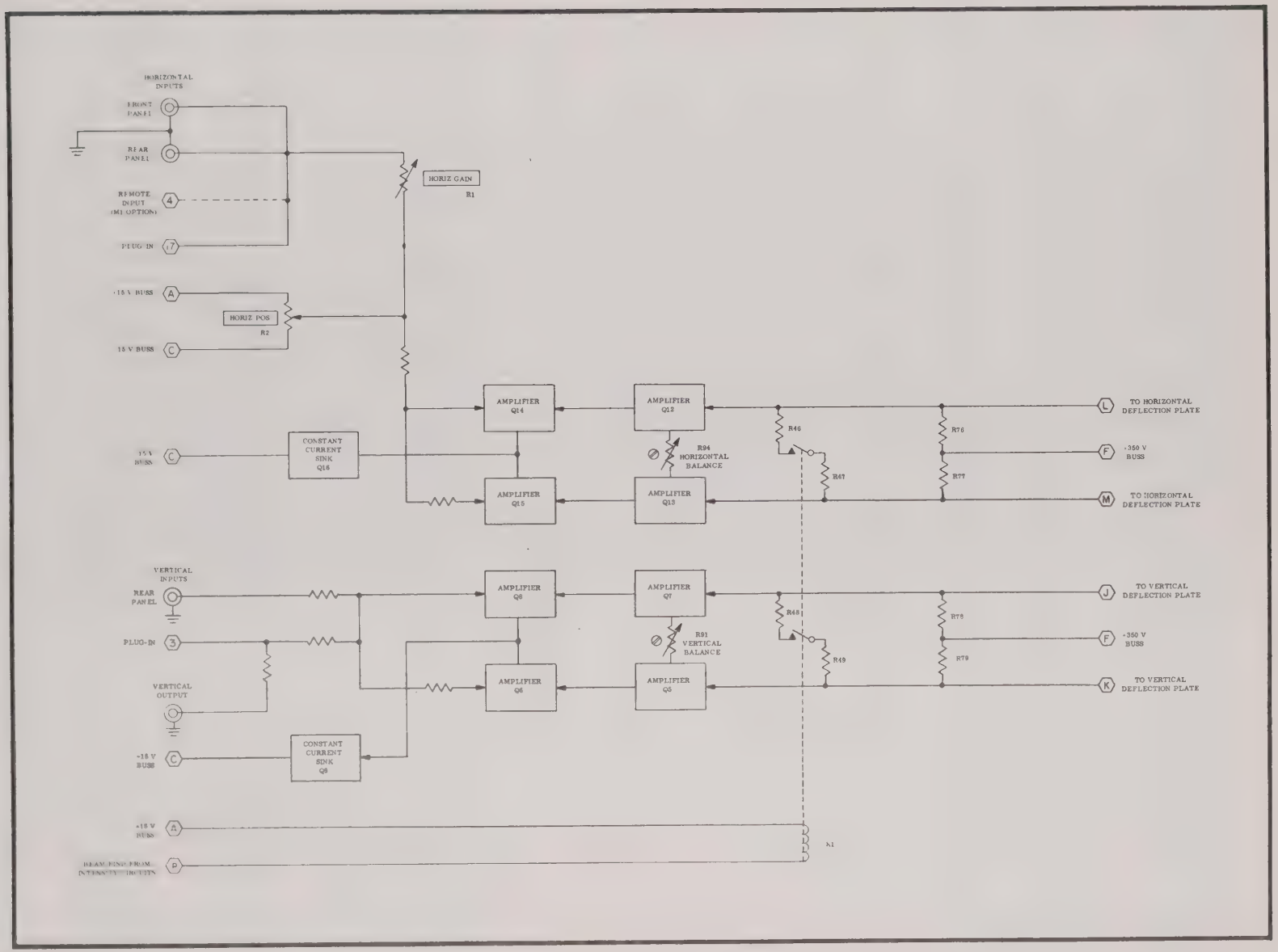


Figure 4.3 Deflection Amplifier Circuits Functional Block Diagram

Vertical Deflection Amplifier. The vertical deflection amplifiers operate in a manner similar to that of the horizontal deflection amplifiers; the vertical deflection circuits do not include a buffer or a position control; these are part of the plug-in vertical amplifier.

4.5 INTENSITY CIRCUITS

Intensity (blanking and marker) circuits are described below and shown in block diagram Figure 4.4 and the schematic diagram in Section 6.

CRT trace intensity is controlled by controlling and modulating the voltage on grid 1 of the CRT. Control of CRT intensity can come from any (or all) of six sources:

- INTENSITY control R5 on the front panel (varies trace brightness)
- Intensity marker input J8 on the rear panel (puts bright dots on trace)
- Blanking input through J7 on the rear panel (blanks retrace or part of trace)
- Blanking input from the plug-in (blanks retrace of part of trace)
- BEAM FIND switch S1 on the front panel (intensifies trace to full brightness)
- From the 540B Sweeper or 50525 Multiband Sweep System through their sweep-stop circuits

All but the last of these sources feed into Summing Amplifier Q1, an operational amplifier. The negative (-) input of this amplifier is normally biased positive through fixed resistor R5 to +15V. The positive (+) input is normally held at zero volts because R1 from the -15V buss and R4 to the +15V buss are the same value. When INTENSITY control R5 on the front panel is turned CW from +15V toward -15V, the output of Q1 increases. An increase in the output of Q1 increases the trace intensity (the exact method is described in detail below).

An intensity marker input through connector J8, resistor R12, and switch S3 will increase the output of Q1 by increasing the positive voltage at the positive summing junction of Q1 (when the marker polarity is positive and S3 is set to +) or by increasing the negative voltage at the negative summing junction (negative marker polarity, S3 to -).

A blanking input through connector J7, resistor R11, and switch S4 will decrease the output of Q1 by placing a negative voltage at the positive summing junction or a positive voltage at the negative summing junction. A blanking input from the plug-in places a negative voltage through R3 to the positive summing junction.

When the front panel BEAM FIND switch (S1) is pressed, -15V power is applied to relay K1 on the deflection board, causing it to be energized. At the same time, -15V power is re-

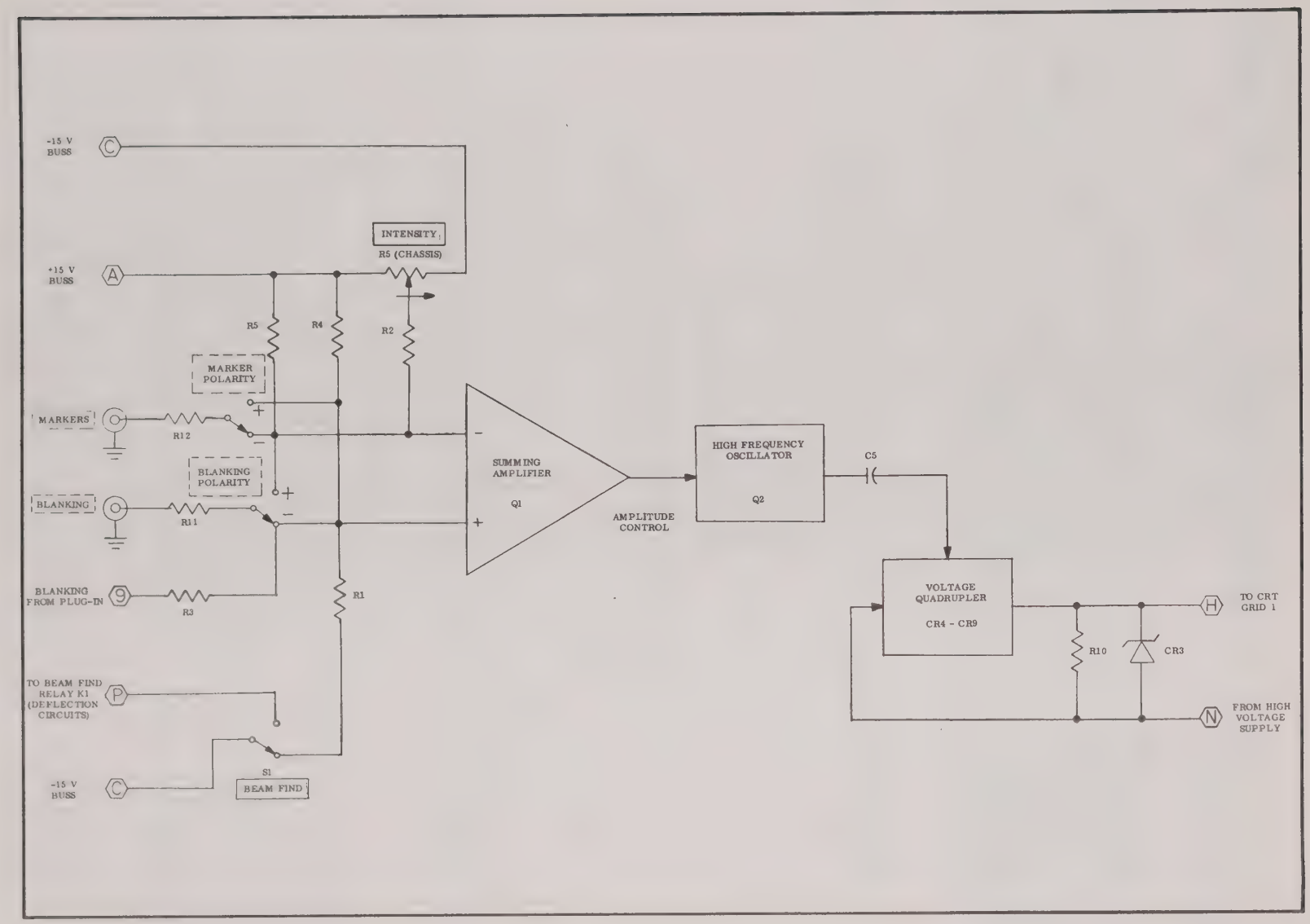


Figure 4.4 Intensity Circuits Functional Block Diagram

moved from the positive summing junction of Q1;this drives Q1 fully positive, resulting in maximum output and maximum trace intensity, regardless of the setting of the front panel INTENSITY control.

Increasing the output of Q1 increases the amplitude of free-running oscillator Q2; the frequency of the oscillator is ≈ 750 kHz. The voltage output of Q2 is varied by Q1 from zero V with no inputs to Q1 (intensity CCW) to ≈ 55 V p-p on "Beam Find". This output is ac-coupled through C5 to a voltage quadrupler containing diodes CR4-CR9. The DC output of the quadrupler is added to the -2.4 kV from the high voltage supply and fed directly to CRT grid 1. Zener diode CR3 limits the output of the quadrupler to 68V. These components are located on High Voltage Supply board A1.

SECTION 5

MAINTENANCE

5.1 GENERAL

The Systron-Donner Model 7000 is a permanently calibrated instrument and should give many years of trouble-free operation. Routine, simple tests can be made periodically to give assurance that the instrument is accurately calibrated and operating properly. This section of the manual describes these tests.

Repairs or calibration accuracy checks should be undertaken only by qualified personnel with sufficient experience and knowledge to ensure that proper test methods are employed Use standard maintenance practices when working on the instrument.

WARNING

YOU ARE EXPOSED TO LETHAL VOLTAGES WHENEVER THE 7000 IS PLUGGED IN AND ANY COVERS ARE OFF.

5.2 ROUTINE MAINTENANCE

The 7000 Display Unit is a rugged instrument, and in normal laboratory environments requires no routine maintenance. When operated under more severe conditions, the instrument should be inspected and cleaned at regular intervals:

a. Turn the power off, then unplug the power connector.

b. Remove the top cover by removing four screws and lifting the cover off. The bottom cover may be removed in the same manner.

c. Remove any accumulated dust or other foreign material with a soft brush and low-pressure dry air. Dust tends to collect around high-voltage circuits.

d. Inspect the unit carefully for loose screws, nuts, etc; tighten any hardware requiring it.

e. Check the unit carefully for damaged or overheated components, pieces of solder or wire, frayed wire insulation, etc.

f. Remove any grease, oil, or corrosion that may be present on the contacts of the plug-in interface connector and the PC card connectors.

g. Replace the covers removed in step b.

5.3 PERFORMANCE CHECKS

Preferred Method. The following performance check may be performed at any time; although an alternate method may be used (see below), these steps will yield superior results:

a. Assemble the following (or equivalent) test equipment and connect it as shown in Figure 5.1:

- Systron-Donner Model 5000A Sweeper
- Systron-Donner Model 401 Function Generator
- Tektronix Model 465 Oscilloscope
- 50 Ω through termination, BNC (Tektronix 011-0049-01)

b. Turn on all test equipment, but do not turn on the 7000 Display Unit.

c. Remove the plug-in vertical amplifier from the 7000 plug-in compartment

d. Set the function generator OUTPUT switch to 50 Ω 0 DB and the AMPLITUDE control fully CCW. Set the OFFSET switch to OUT, and the remaining controls to provide a 1 kHz square wave.

e. Turn on power to the 7000.

f. Set the oscilloscope vertical sensitivity control to 1 V/Div and the channel A coupling switch to AC. Set the trigger coupling switch to AC, SLOPE to +, and SOURCE to EXT. Set the time base switch to 1 ms/Div.

g. Set the 5000A SWEEP SECONDS control to .01, VERNIER to X1, and TRIG switch to RECUR. Set the MODE control to WIDE F1-F2, but do not bother to set any signal or marker frequencies. Set the 5000 RF LEVEL control maximum CCW.

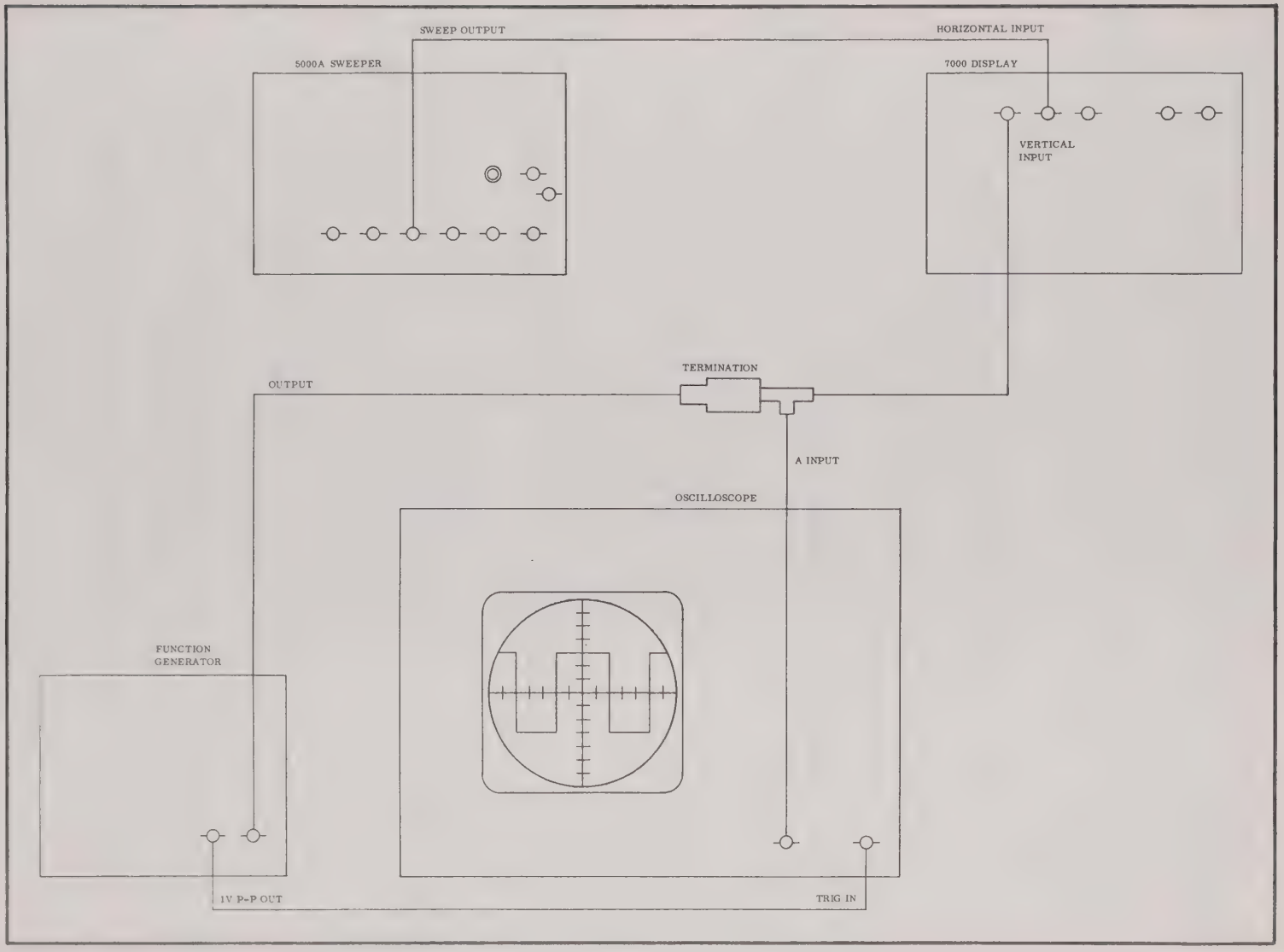


Figure 5.1 Test Setup for Preferred Performance Check

h. Slowly advance the function generator AMPLITUDE control until the oscilloscope shows the output to be exactly 10 V p-p (10 vertical division). Adjust the oscilloscope controls as required for a stable display of 3 or 4 cycles.

i. Adjust the 7000 HORIZ GAIN and HORIZ POS controls so that the trace exactly fills the 10 divisions of the X axis.

NOTE

Although it is not necessary to synchronize the 5000A/ 7000 sweep with the output of the function generator, it may be done simply by adjusting the function generator frequency until the trace on the 7000 ceases free-running or crawling.

j. Check the screen of the display unit (7000) to ensure that the displayed value of the waveform is exactly 5 major divisions (the input sensitivity is 2 V/Div at the rear panel VERTICAL INPUT connector).

k. Reduce the waveform generator amplitude to display 2 V p-p (2 divisions) on the oscilloscope; determine that the 7000 shows a display of exactly 1 division

l. Turn the waveform generator AMPLITUDE control fully CCW.

m. Disconnect the cable from the 7000 rear panel VERTICAL INPUT connector; connect this end of the cable to the rear panel BLANKING connector. Set the BLANKING POLARITY switch to +.

n. Connect a cable between the 5000A rear panel 1 KHZ OUTPUT connector and the 7000 rear panel VERTICAL OUTPUT connector.

o. Set the 5000 plug-in 1 KHZ toggle switch to ON: the other 3 switches are OFF.

p. Adjust the 7000 INTENSITY control for a normal display, then, if necessary, adjust the 5000 plug-in 1 KHZ ADJ control and/or 5000A SWEEP SECONDS VERNIER control to produce a stable display on the CRT.

q. Set the function generator frequency to approximately 250 Hz, and increase the output amplitude to 2 V p-p on the oscilloscope screen.

r. Slowly adjust the frequency of the waveform generator until the display is stable.

s. At this time, the CRT trace will consist of 7 or 8 cycles of the 1 kHz square wave from the sweeper, but part of the trace will be blanked out. (Ignore the retrace.) Adjust the function generator AMPLITUDE control for zero output, then slowly advance it until portions of the trace are blanked.

t. Measure the output of the function generator on the oscilloscope; determine that the voltage required to blank the trace from normal intensity is 2 V or less.

u. Advance the 7000 INTENSITY control to maximum CW and measure the voltage required to blank the trace. It must be 8 V or less.

v. Transfer the cable from the BLANKING connector to the MARKERS connector on the rear panel of the 7000; set the MARKERS POLARITY switch to +.

w. Turn the 7000 INTENSITY control fully CCW, then advance the function generator AMPLITUDE control until the trace can be seen. Be sure that the voltage required to intensify the trace from zero intensity is 8 V or less.

x. Turn the function generator AMPLITUDE control fully CCW, then advance the 7000 INTENSITY control until the trace can be seen.

y. Slowly advance the function generator AMPLITUDE control until portions of the trace are noticably brighter than others. Determine that the voltage required to intensify the trace from normal intensity is 2 V or less.

z. This concludes the preferred performance check for the Model 7000 Display Unit.

Alternate Method. If the equipment is not available, or for some other reason the preferred method of checking performance cannot be used, the following alternate method should provide satisfactory results:

a. With power to the display unit turned off, remove the plug-in vertical amplifier from the plug-in compartment.

b. Turn the power back on.

c. Use a calibrated laboratory oscilloscope that can supply calibrator, sawtooth, and + gate outputs; a Tektronix 530 or 540 series oscilloscope with plug-in.

d. Connect the equipment as shown in Figure 5.2.

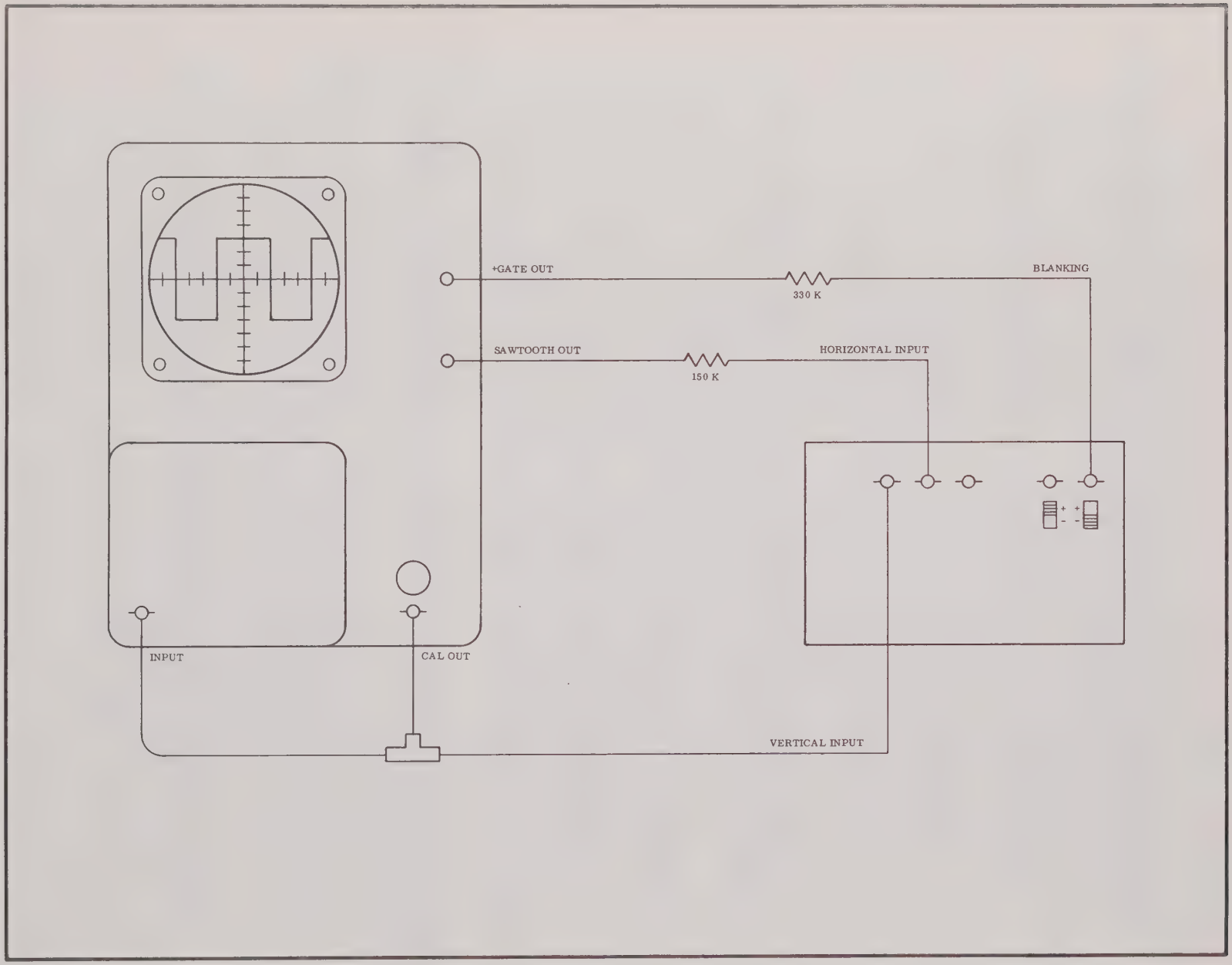


Figure 5.2 Test Setup for Alternate Performance Check

e. Set the calibrator to 5 volts.

f. Adjust the oscilloscope controls so that a stable display of 3 or 4 cycles is displayed on the screen.

g. Adjust the 7000 HORIZ GAIN and HORIZ POS controls so that the trace exactly fills the 10 divisions of the X axis.

h. Using the oscilloscope graticule, determine the voltage output of the calibrator.

i. Check the screen of the display unit to ensure that the displayed value is correct. For example, if the scope calibrator is set to 5 V and the oscilloscope preamplifier is set to 1 V/Div, the trace should cover exactly 5 divisions. The 7000 trace should then cover exactly 2-1/2 major divisions (the input sensitivity is 2 V/Div at the rear panel VERTICAL INPUT connector).

j. Adjust the INTENSITY control of the 7000 so that the trace is visible, but the retrace line is not.

k. Remove the cable from the BLANKING connector; the retrace line should be visible. Re-connect this cable.

l. Change the BLANKING POLARITY switch from - to +; the trace should disappear, leaving only the retrace visible.

m. Set the BLANKING POLARITY switch back to -.

n. Move the cable from BLANKING to MARKERS; the + gate of the oscilloscope will still blank the retrace.

o. Set the 7000 series plug-in MV/Div or DB/Div switch to its least sensitive (maximum CCW) position.

p. Turn the 7000 power off, then insert and lock the plug-in. Turn the power back on.

q. Adjust the plug-in OFFSET control to center the trace.

r. Increase the oscilloscope calibrator OUTPUT to 10 volts.

s. Check the actual level of this signal with the oscilloscope and determine that it is properly represented on the display unit.

t. This concludes the alternate performance check for the Model 7000 Display Unit.

5.4 CORRECTIVE MAINTENANCE

Initial Checks. The 7000 is permanently calibrated at the factory by selection of precision fixed components. Other than the internal adjustments to compensate for aged or replacement CRT's, no calibration adjustments are provided or required. Only component failure can cause degradation of performance, although the CRT will normally decrease somewhat in brightness as it ages.

In the event of apparent malfunction of the 7000, refer to Table 5.1.

Table 5.1 Malfunction Checklist

Malfunction	Check
No Trace - Pilot Light Out	Press ON-OFF Switch Check power cord Check fuse Check power source Check 115V/ 230V switch Check pilot light
No Trace - Pilot Light on	Check INTENSITY control Press BEAM FIND switch Check plug-in OFFSET control
Dot on screen - no deflection	Check signal source power switch Check signal source control positions Check input cables
No blanking No markers	Check signal source control positions Check signal source outputs Check input cables Check rear panel POLARITY switch settings.
Trace dim, astigmatic, out of focus	Check INTENSITY and FOCUS control settings Perform steps t, aa, and ab of "CRT Replacement" Check intensity circuits Replace CRT

CRT Replacement. To replace a defective or aged CRT, proceed as follows:

a. Check the notices at the front of this manual if your CRT is still in warranty; you may be entitled to a new CRT.

b. Unplug the power cord and remove the 7000 to a work bench.

c. Make a soft surface for the work bench.

d. Remove the top panel by unscrewing four screws.

e. Remove the front panel by unscrewing four screws.

f. Disconnect the high voltage anode connector on the side on the CRT, near the front panel.

WARNING

USE GREAT CARE HANDLING THE CRT TO AVOID IMPLOSION. DO NOT DROP OR STRIKE IT. IT IS RECOMMENDED THAT GOGGLES BE WORN TO PROTECT THE EYES FROM FLYING GLASS.

g. Loosen the clamp at the base of the CRT.

h. Slide the CRT forward. While steadying the CRT with one hand, remove the CRT socket with the other.

i. Withdraw the CRT straight out from the front of the unit.

j. Wrap the CRT in some soft, protective material until it can be disposed of.

k. Unpack the new CRT.

l. Carefully install it into the CRT shield through the front of the 7000.

m. Connect the CRT socket to the base of the CRT.

n. Re-install the front panel.

o. Reconnect the high voltage anode connector.

p. Push the CRT forward until it is against the plastic graticule, then tighten the base clamp.

WARNING

YOU ARE EXPOSED TO LETHAL VOLTAGES WHEN THE UNIT IS OPERATED WITH THE TOP COVER REMOVED.

q. Connect the power cord to the 7000 and turn the unit on.

r. Verify that a CRT dot is present. Focus the dot as sharply as possible.

s. Turn the INTENSITY control fully CCW.

t. Turn the INTENSITY control up slightly; verify that the dot can be seen.

u. Connect a short circuit between the center conductor and ground of rear-panel BNC connectors J4 (HORIZONTAL INPUT) and J9 (VERTICAL INPUT).

v. Set the front-panel HORIZ POS control to the center of its rotation.

w. Adjust horizontal balance control R94, shown in Figure 5.3, to center the dot along the horizontal (X) axis graticule marking.

x. Adjust vertical balance control R91, also shown in Figure 5.3, to center the dot along the vertical (Y) axis graticule marking.

y. Repeat steps w and x to ensure that the dot is centered.

z. Remove the short circuits from J4 and J9.

aa. With a sweep source of some kind, deflect the dot across the screen. If the dot changed shape, or if the trace line is of varying thickness, adjust the astigmatism control shown in Figure 5.3.

ab. Readjust the FOCUS control for the sharpest trace. Adjust the FOCUS and astigmatism controls as necessary to ensure that the trace is sharp at all settings of the INTENSITY control and across the full width of the screen.

ac. Turn off the power and replace the top cover.

Trouble Isolation. Printed circuit card extender 950646 (33-pin) is available for servicing the plug-in P.C. cards. To allow access to the plug-in interface connector, or for servicing plug-in amplifiers, a Model 9205 extender should also be obtained. A plug-in inverter is available as Model 9206, and a plug-in dummy load for testing the 7000 power supply is sold as Model 9204.

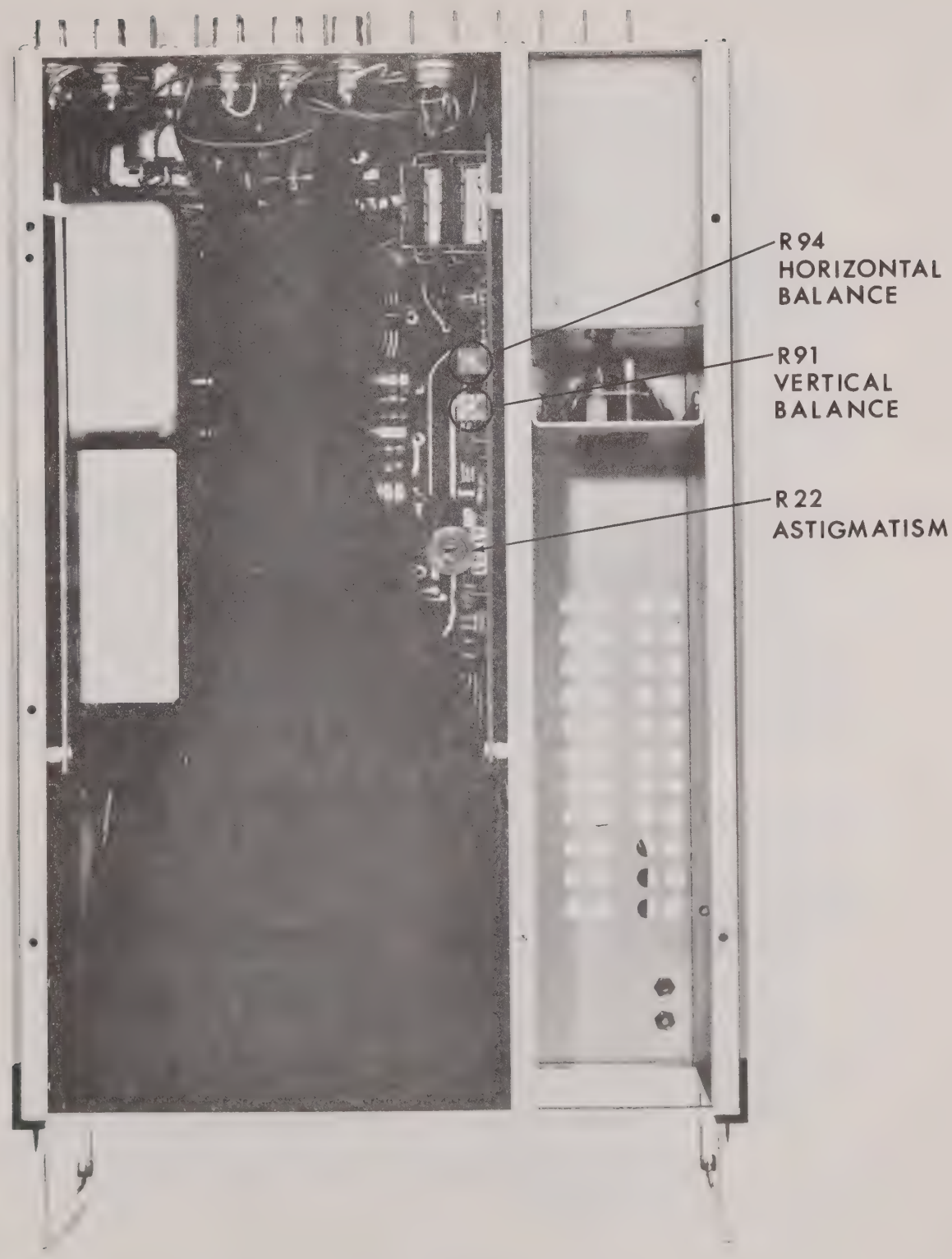


Figure 5.3 Internal Adjustments

WARNING

LETHAL VOLTAGES ARE PRESENT THROUGHOUT THE DISPLAY UNIT. DO NOT ASSUME THAT SEMICONDUCTOR CASES CARRY ONLY SAFE VOLTAGES.

Repair of the 7000 is limited to location and replacement of defective components. To avoid damage to the printed circuit cards and to precision components, solder or remove components only with a low power (25 to 50W, 500 to 700°F) soldering iron. Do not use soldering guns or large irons. Use only 60-40 or 63-37 rosin core solder. To remove integrated circuit operational amplifiers, use a special iron tip that unsolders all leads at the same time, (availalbe from Ungar and other manufacturers). Remove excess solder from circuit card holes with a vacuum device.

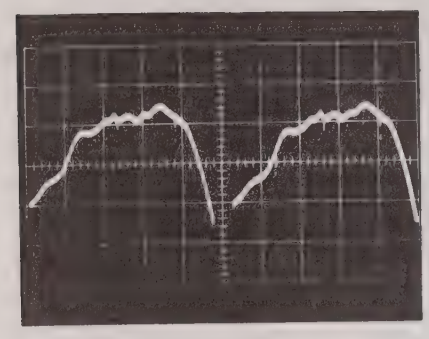
Standard trouble shooting techniques should be used to locate defective components. To aid in this, Figure 5.4 shows waveforms measured at various points throughout the 7000 circuitry. Figures 5.5 and 5.6 show the physical locations of the test points in 5.4.

An S-D Model 5000A supplied blanking, marker, and horizontal inputs to the 7000. The sweeper was equipped with a 5013 plug-in, and swept from 2 to 4 GHz in the unleveled mode. The output of the 5013 was fed through a 10 dB pad and crystal detector to the input of a 7010 plug-in amplifier. The trace on the 7000 screen is a plot of the power level variations across the octave band (if the 5013 had been leveled, there would have been no variation).

The oscilloscope used was a Tektronix Model 531A with type L plug-in; any good triggered oscilloscope will work as well. Some of the measurements were made with a P6006 (x10) or a P6013 (x1000) high-voltage probe. The notes under each oscillogram give the oscilloscope vertical sensitivity (including the effects of attenuating probes or the x10 amplifier in the type L) coupling, sweep rate, and trigger mode; where significant, the DC zero point or DC voltage at a point is also given. Figures 5.5 and 5.6 show the test points.

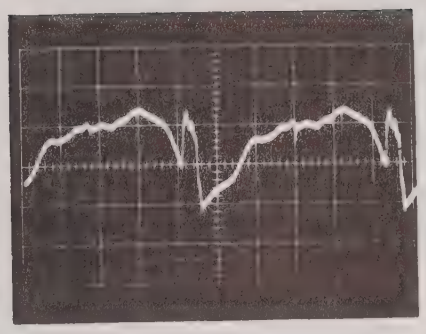
CAUTION

BE VERY CAREFUL WITH OSCILLOSCOPE AND VOLTMETER PROBES TO AVOID ACCIDENTALLY BRIDGING TWO POINTS OR SHORTING A COMPONENT LEAD OR WIRE TO GROUND. LACK OF ADEQUATE CARE WITH SEMICONDUCTOR CIRCUITS CAN TURN RELATIVELY MINOR PROBLEMS INTO COSTLY REPAIRS.



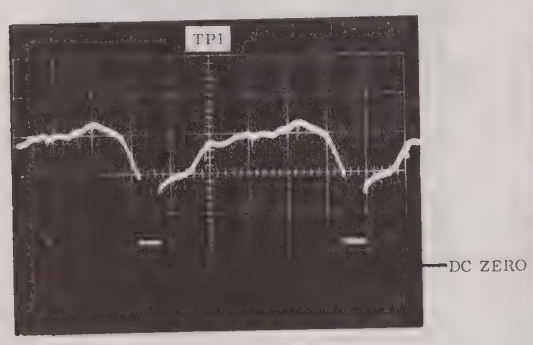
INTERFACE CONNECTOR PIN 3
(Input Signal from Plug-in; Sweeper
Plug-in RETRACE Switch OFF)

1 V/Div Cplng: AC
2 mS/Div Trig: Ext + Auto



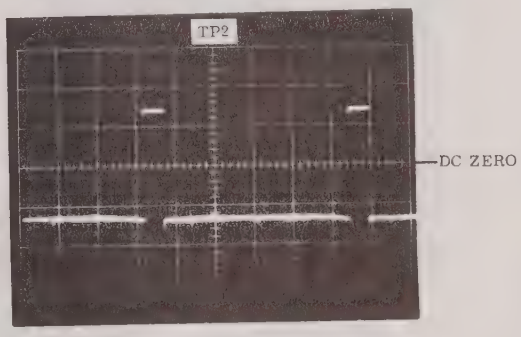
INTERFACE CONNECTOR PIN 3
(Input Signal from Plug-in; Sweeper
Plug-in RETRACE Switch ON)

1 V/Div Cplng: AC
2 mS/Div Trig: Ext + Auto



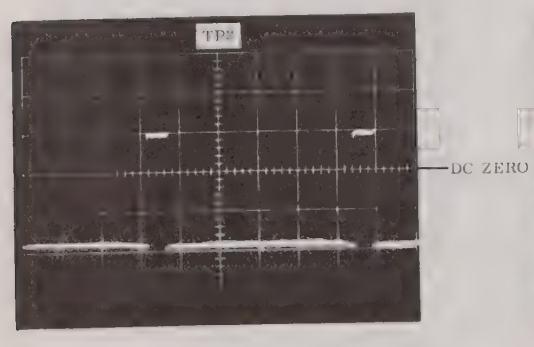
BOARD A3 - PIN 30

20 V/Div Cplng: DC
2 mS/Div Trig: Ext + Auto



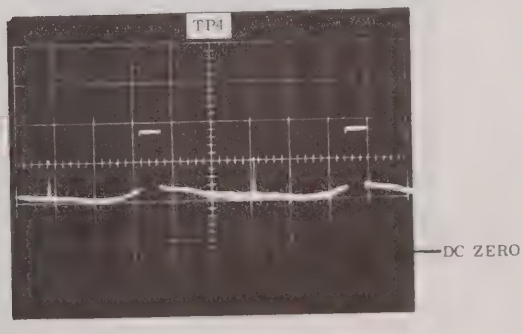
BOARD A3 - Q15 BASE

1 V/Div Cplng: DC
2 mS/Div Trig: Ext + Auto



BOARD A3 - Q16 COLLECTOR

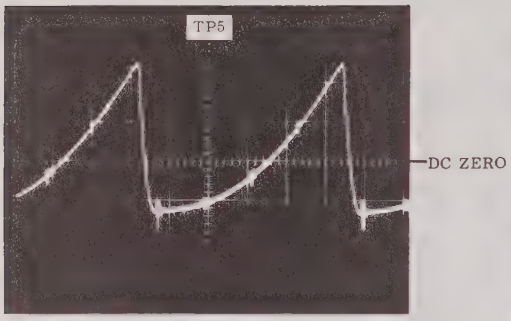
.05 V/Div Cplng: DC
2 mS/Div Trig: Ext + Auto



BOARD A3 - PIN 29

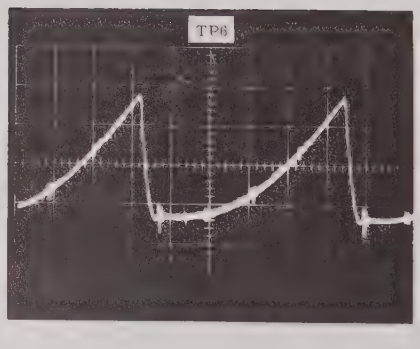
100 V/Div Cplng: DC
2 mS/Div Trig: Ext + Auto

Figure 5.4 Waveforms (sheet 1 of 3)



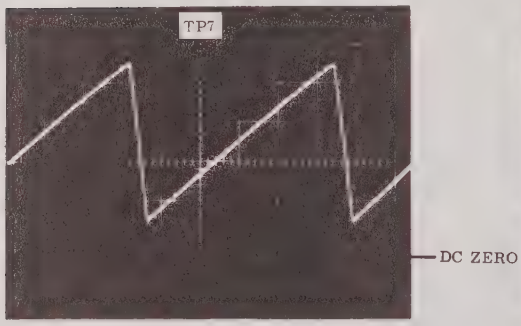
BOARD A3 - Q9 COLLECTOR

1 V/Div Cplng: DC
2 mS/Div Trig: Ext + Auto



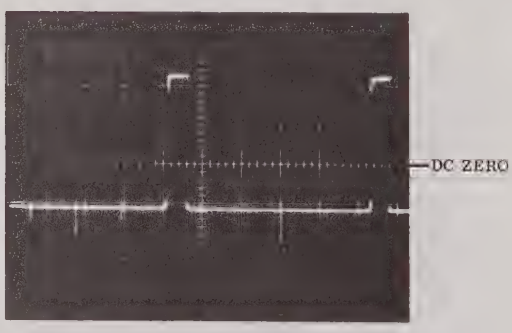
BOARD A3 - Q6 BASE

.05 V/Div Cplng: AC
2 mS/Div Trig: Ext + Auto



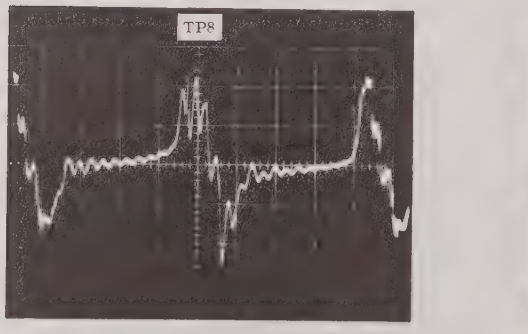
BOARD A3 - PIN 33

50 V/Div Cplng: DC
2 mS/Div Trig: Ext + Auto



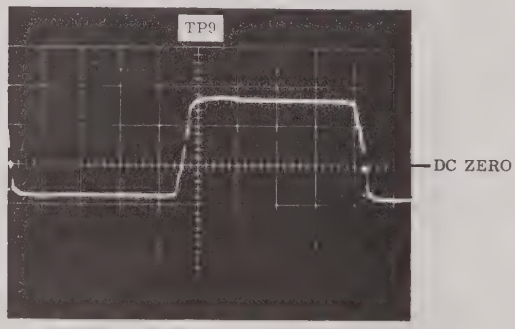
INTERFACE CONNECTOR PIN 11

0.2 V/Div Cplng: DC
2 mS/Div Trig: Ext + Auto



BOARD A1 - T1 PIN 5

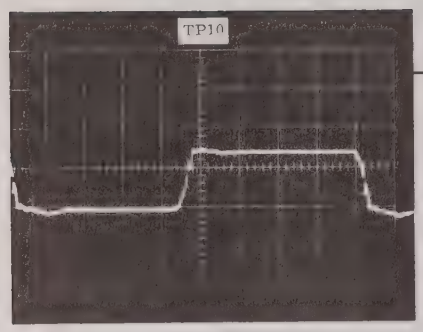
0.2 V/Div Cplng: AC
5 μS/Div Trig: Int + AC



BOARD A1 - T1 PIN 3

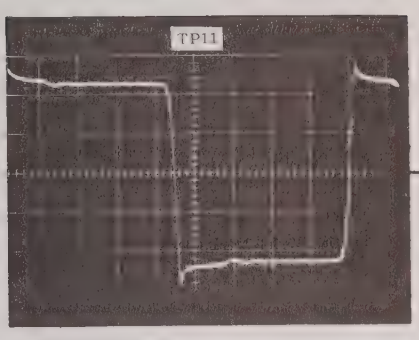
20 V/Div Cplng: DC
5 μS/Div Trig: Int - AC

Figure 5.4 Waveforms (sheet 2 of 3)



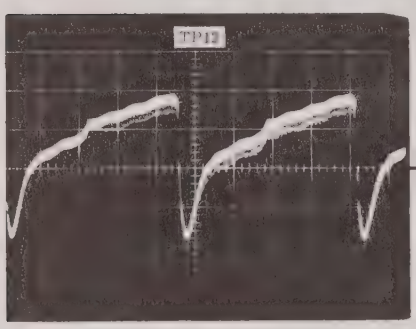
BOARD A1 - T1 PIN 4

5 V/Div Cplng: DC
5 μS/Div Trig: Int - AC



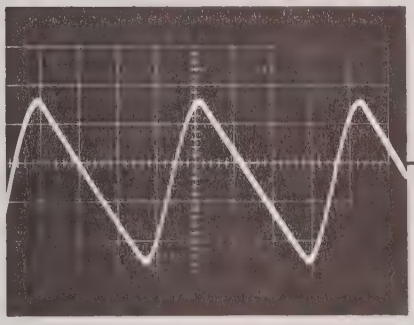
BOARD A1 - T1 PIN 8

500 V/Div Cplng: DC
5 μS/Div Trig: Int + AC



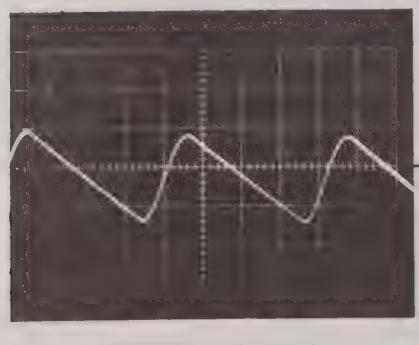
BOARD A1 - CR17 ANODE

5 V/Div Cplng: AC
10 μS/Div Trig: Int + HF Sync



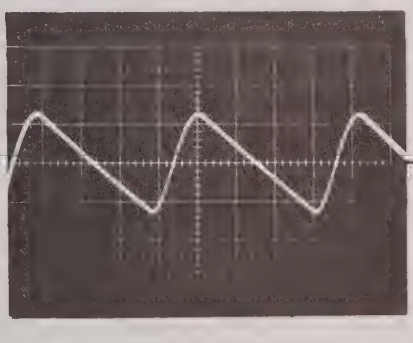
CHASSIS - Q7 COLLECTOR

2 V/Div Cplng: AC
2 mS/Div Trig: Int + AC



CHASSIS - Q6 COLLECTOR

0.5 V/Div Cplng: AC
2 mS/Div Trig: Int + AC



CHASSIS - Q5 COLLECTOR

0.5 V/Div Cplng: AC
2 mS/ Div Trig: Int + AC

Figure 5.4 Waveforms (sheet 3 of 3)

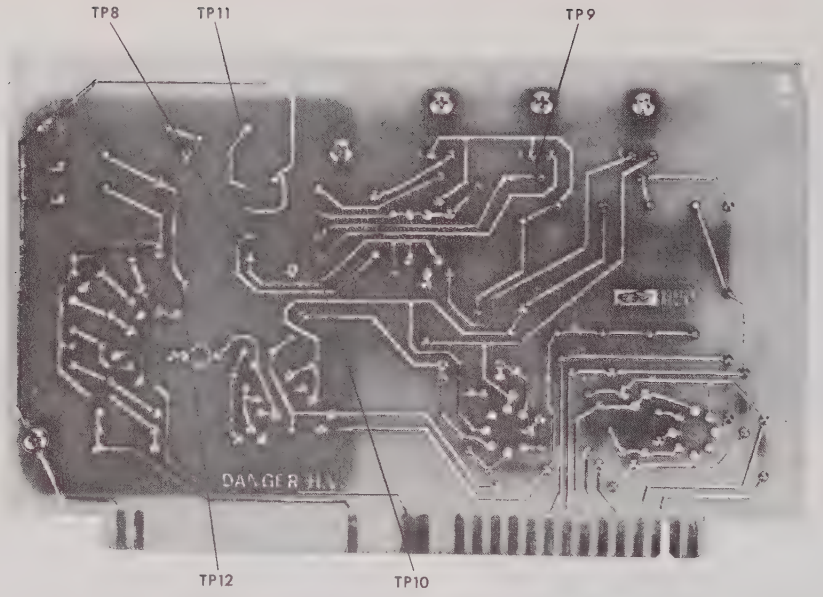


Figure 5.5 A1 (High Voltage) Board Test Points

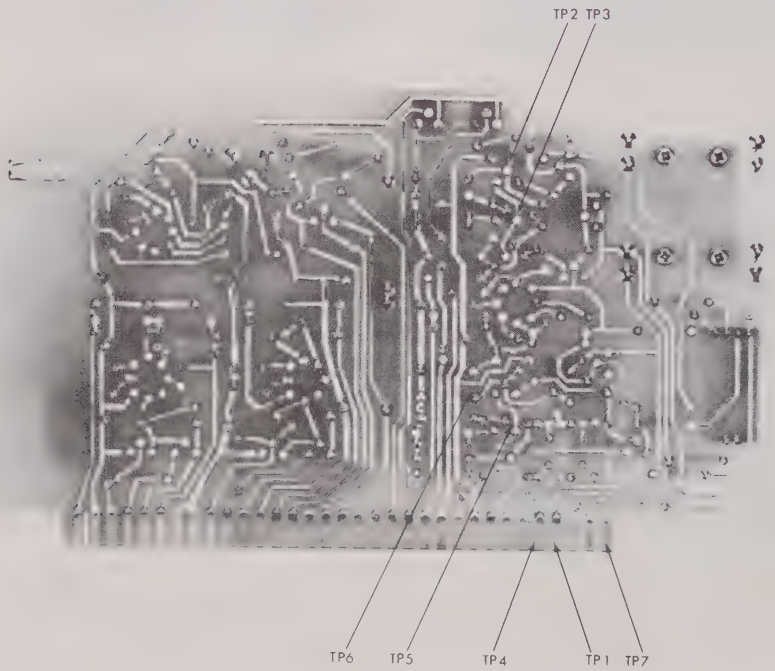


Figure 5.6 A3 (Deflection) Board Test Points

SECTION 6

DRAWINGS AND PARTS LISTS

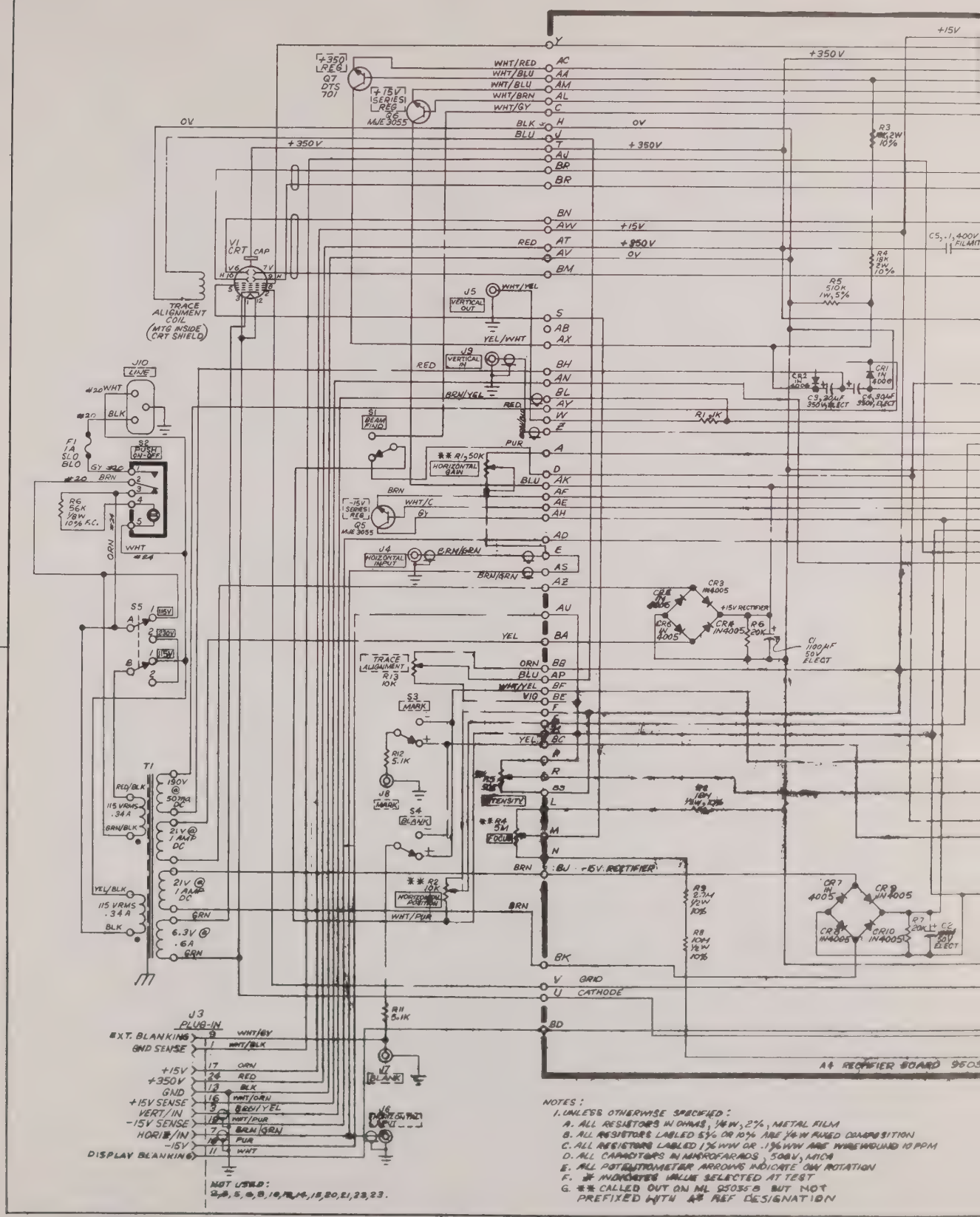
6.1 INTRODUCTION

This section contains the schematic diagram, assembly drawings, and parts lists for the Systron-Donner Model 7000 Display Unit. These drawings are arranged in the following order:

- Schematic Diagram
- Chassis Electronic Parts List
- A1 (High Voltage) Board Parts Location Diagram
- A1 Board Parts List
- A3 (Deflection) Board Parts Location Drawing
- A3 Board Parts List
- A4 (Rectifier or Motherboard) Parts Location Drawing
- A4 Board Parts List
- Non-structural Mechanical Parts List

Most replacement parts are available locally, but any parts needed can be ordered from the Service Division of Systron-Donner at the address shown on the service card in the front of this manual.

Be sure to give the complete reference designation for all parts ordered; this would comprise the instrument model number, board upon which the component is located, and component number. Therefore, capacitor C5 on the rectifier board must be referred to as "7000A4C5", the instrument power switch must be referred to as "7000S2", high-voltage transformer T1 on the high-voltage board as "7000A1T1", and so forth.



NOTES:
1. UNLESS OTHERWISE SPECIFIED:
   A. ALL RESISTORS IN OHMS, 1/4W, 2%, METAL FILM
   B. ALL RESISTORS LABLED 5% OR 10% ARE 1/4W FUSED COMPOSITION
   C. ALL RESISTORS LABLED 1% WW OR .1% WW ARE WIREWOUND 10 PPM
   D. ALL CAPACITORS IN MICROFARADS, 500V, MICA
   E. ALL POTENTIOMETER ARROWS INDICATE CW ROTATION
   F. * INDICATES VALUE SELECTED AT TEST
   G. ** CALLED OUT ON ML 95035-B BUT NOT PREFIXED WITH A4 REF DESIGNATION

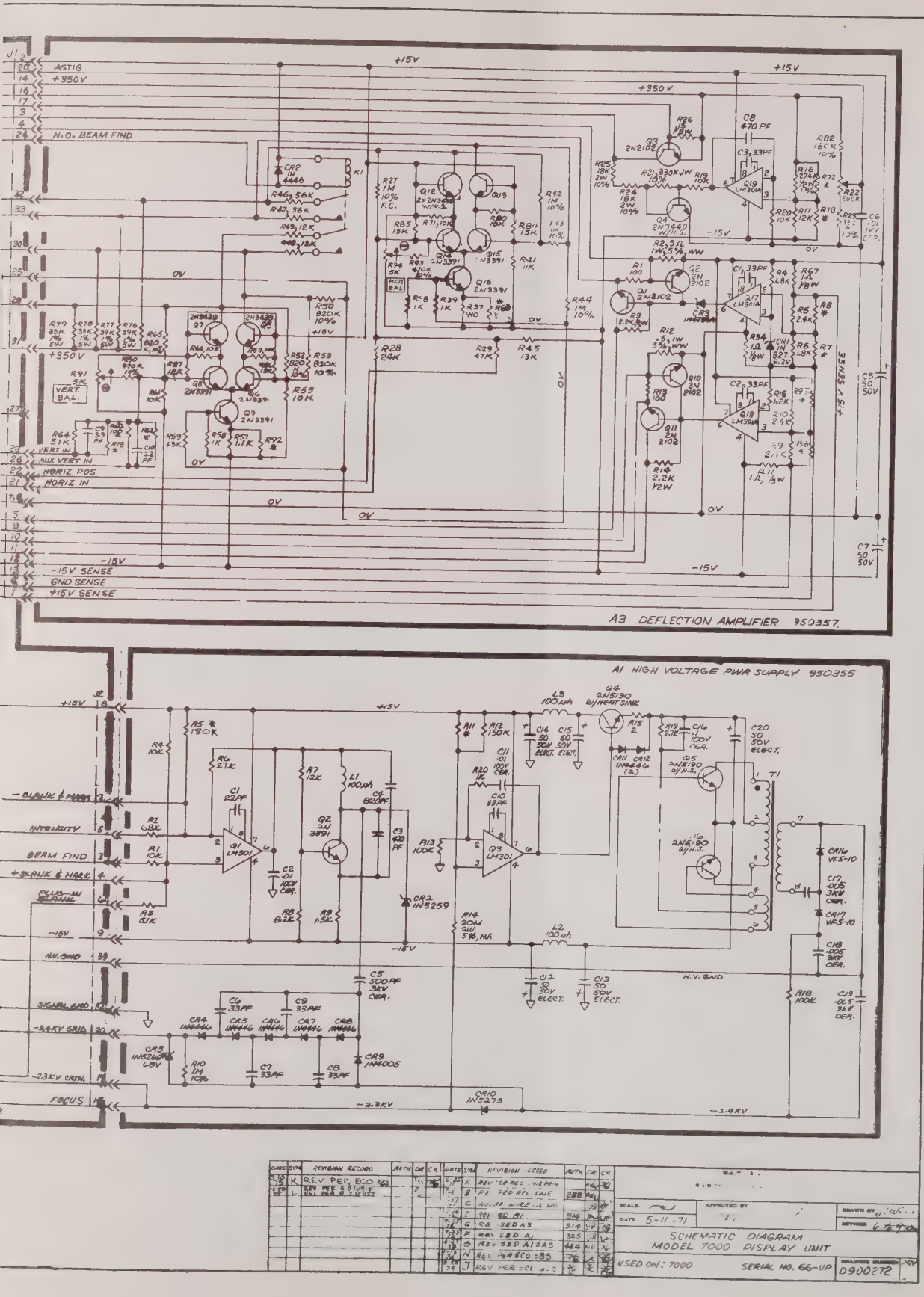


Figure 6.1 Model 7000 Display Unit Schematic Diagram

CHASSIS ELECTRONIC PARTS LIST

REF.	DESCRIPTION	PART NO.
A1	P.C. BOARD ASSEMBLY, High Voltage Power Supply	950355
A2	NOT USED	
A3	P.C. BOARD ASSEMBLY, Deflection Amplifier	950357
A4	P.C. BOARD ASSEMBLY, Rectifier (Motherboard)	950358
F1	FUSE, Slow Blow, 1A (for 115V Power)	510001
F1	FUSE, Slow Blow, 0.5A (for 230 V Power) NOT SUPPLIED	510002
G1	CABLE, AC Power (Belden 17258S)	600000
J3	CONNECTOR, Receptacle, 24 pin female (Amphenol 26-190-24)	210010
J4-J9	CONNECTOR, Receptacle, coaxial BNC (UG-1094/U)	310011
J10	CONNECTOR, Receptacle, AC line (Tower 1061-3)	210050
J11	CONNECTOR, Receptacle, M1 Remote (Amphenol 91-T-3363)	210171
L1	COIL ASSEMBLY, Trace Alignment	948217
Q5, Q6	TRANSISTOR, NPN Silicon, MJE 3055 (Motorola)	485011
Q7	TRANSISTOR, NPN Silicon, DTS 701 (Delco)	485061
R1, R5	RESISTOR, Variable, 50 kΩ, ABWA1GO48F503UA (Allen-Bradley)	479505
R2	RESISTOR, Variable, 10 kΩ, ABWA1GO48F103UA (Allen-Bradley)	479507
R4	RESISTOR, Variable, 5 MΩ, ABWA1GO48F505UA (Allen-Bradley)	479506
R6	RESISTOR, Fixed Composition, 56 kΩ, 1/8 W, 10%	475550
R11, R12	RESISTOR, Fixed Metal Film, 5100 Ω, 1/4 W, 2%	471449
R13	RESISTOR, Variable, 10 kΩ, AWBA1GO12S103UA (Allen-Bradley)	479521
S1	SWITCH, Pushbutton, SPDT (Beam-finder)(Grayhill 46-110R)	510044
S2	SWITCH, Illuminated, SPDT (Power) (Marco-Oak SW616-26)★	510028
S3, S4	SWITCH, Slide, SPDT (Marker and Blanking Polarity)(Smith 8655)	510043
S5	SWITCH, Slide, DPDT (115/230V) (Switchcraft 46256LF)	510040
T1	TRANSFORMER, Power	560006
V1	TUBE, Cathode Ray (P2 Phosphor)	570001
XF1	HOLDER, Fuse (Littelfuse 342004)	510010
XV1	SOCKET, CRT, modified	960142
XV2	SOCKET, CRT, anode (Cinch-Jones 3A1)	210162

★ Replacement lamp is Chicago Miniature BA-1B (Part No. 390004)

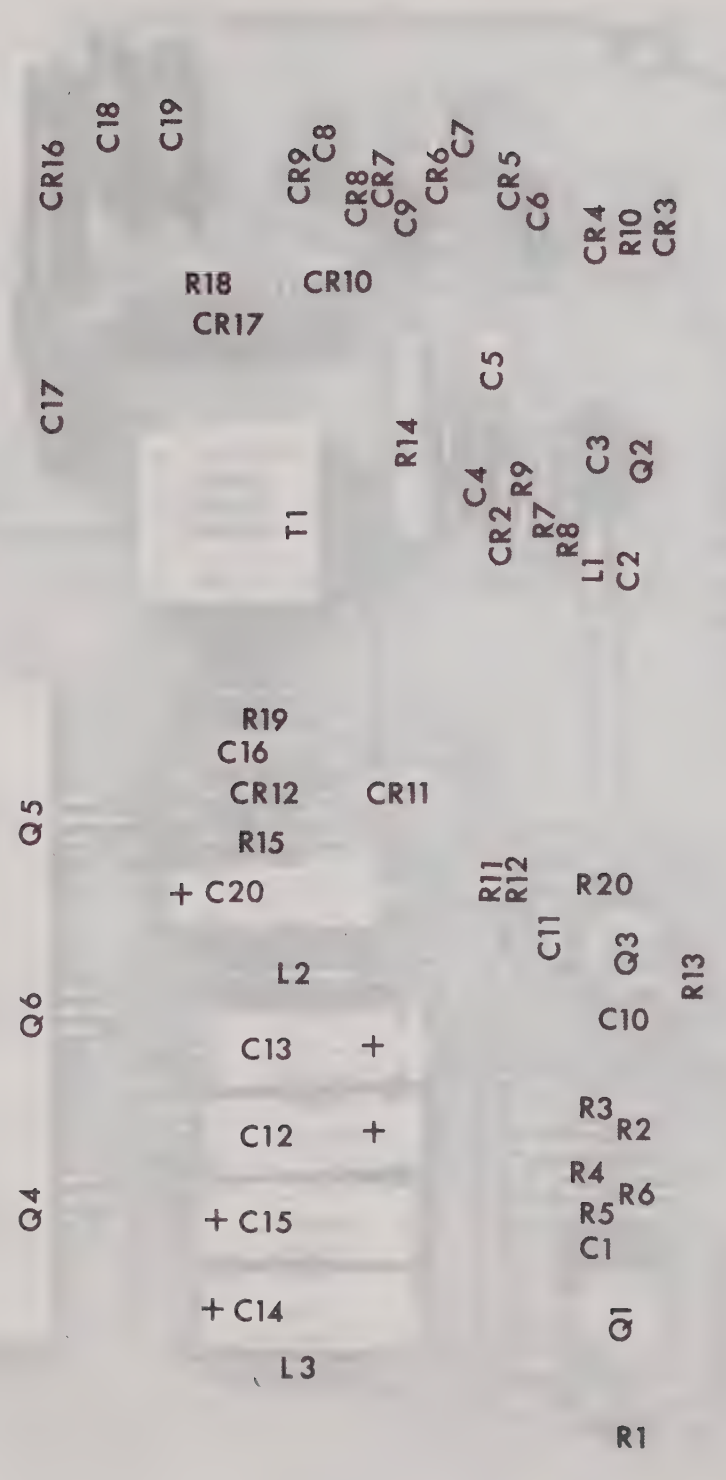


Figure 6.2 A1 P.C. Board Assembly Electronic Parts Location

A1 P.C. BOARD ASSEMBLY ELECTRONIC PARTS LIST

REF.	DESCRIPTION	PART NO.
A1	P.C. BOARD	936138
C1	CAPACITOR, Mica, 22 pF, 500 V	155467
C2, C11	CAPACITOR, Ceramic, .01 μF, 100 V	150100
C3	CAPACITOR, Mica, 470 pF, 500 V	155515
C4	CAPACITOR, Mica, 820 pF, 500 V	155540
C5	CAPACITOR, Ceramic, 500 pF, 3 kV	150923
C6-C10	CAPACITOR, Mica, 33 pF, 500 V	155472
C12-C15, C20	CAPACITOR, Electrolytic, 50 μF, 50 V	152410
C16	CAPACITOR, Ceramic, 0.1 μF, 100 V	150102
C17-C19	CAPACITOR, Ceramic, .005 μF, 3 kV	150011
CR2	DIODE, Zener, 39 V, 1N5259 (Motorola)	480076
CR3	DIODE, Zener, 68 V, 1N5266 (Motorola)	480018
CR9	DIODE, Silicon, 1N4005	480003
CR4-CR8, CR11, CR12	DIODE, Silicon, 1N4446	480004
CR10	DIODE, Zener, 120 V, 1N5273 (Motorola)	480072
CR16, CR17	DIODE, Silicon, VF5-10 (Varo)	480060
L1	INDUCTOR, RF, 100 μH	180040
L2, L3	INDUCTOR, RF, 100 μH	180082
Q1, Q3	INTEGRATED CIRCUIT, LM301A (National)	480655
Q2	TRANSISTOR, NPN Silicon, 2N3391 (General Electric)	485006
Q4-Q6	TRANSISTOR, NPN Silicon, 2N5190 (Motorola)	485059
R1, R4	RESISTOR, Metal Film, 10 kΩ ±2%, 1/4 W	471456
R2	RESISTOR, Metal Film, 68 kΩ ±2%, 1/4 W	471476
R3	RESISTOR, Metal Film, 5100 Ω ±2%, 1/4 W	471449
R5	RESISTOR, Metal Film, Value determined at test	
R6	RESISTOR, Metal Film, 27 kΩ ±2%, 1/4 W	471466
R7	RESISTOR, Metal Film, 12 kΩ ±2%, 1/4 W	471458
R8	RESISTOR, Metal Film, 8200 Ω ±2%, 1/4 W	471454
R9	RESISTOR, Metal Film, 1500 Ω ±2%, 1/4 W	471436
R10	RESISTOR, Composition, 1 MΩ ±10%, 1/4 W	475678
R11	RESISTOR, Value determined at test	
R12	RESISTOR, Metal Film, 130 kΩ ±2%, 1/4 W	471483
R13, R18	RESISTOR, Metal Film, 100 kΩ ±2%, 1/4 W	471480
R14	RESISTOR, Metal Film, 20 MΩ ±5%, 2 W	473950
R15	RESISTOR, Metal Film, 2 Ω ±2%, 1/4 W	470671

A1 P.C. BOARD ASSEMBLY ELECTRONIC PARTS LIST (CONT'D)

REF.	DESCRIPTION	PART NO.
R16	NOT USED	
R19	RESISTOR, Metal Film, 2700 Ω ±2%, 1/4 W	471442
R20	RESISTOR, Metal Film, 1000 Ω ±2%, 1/4 W	471432
T1	TRANSFORMER, High Voltage	560008

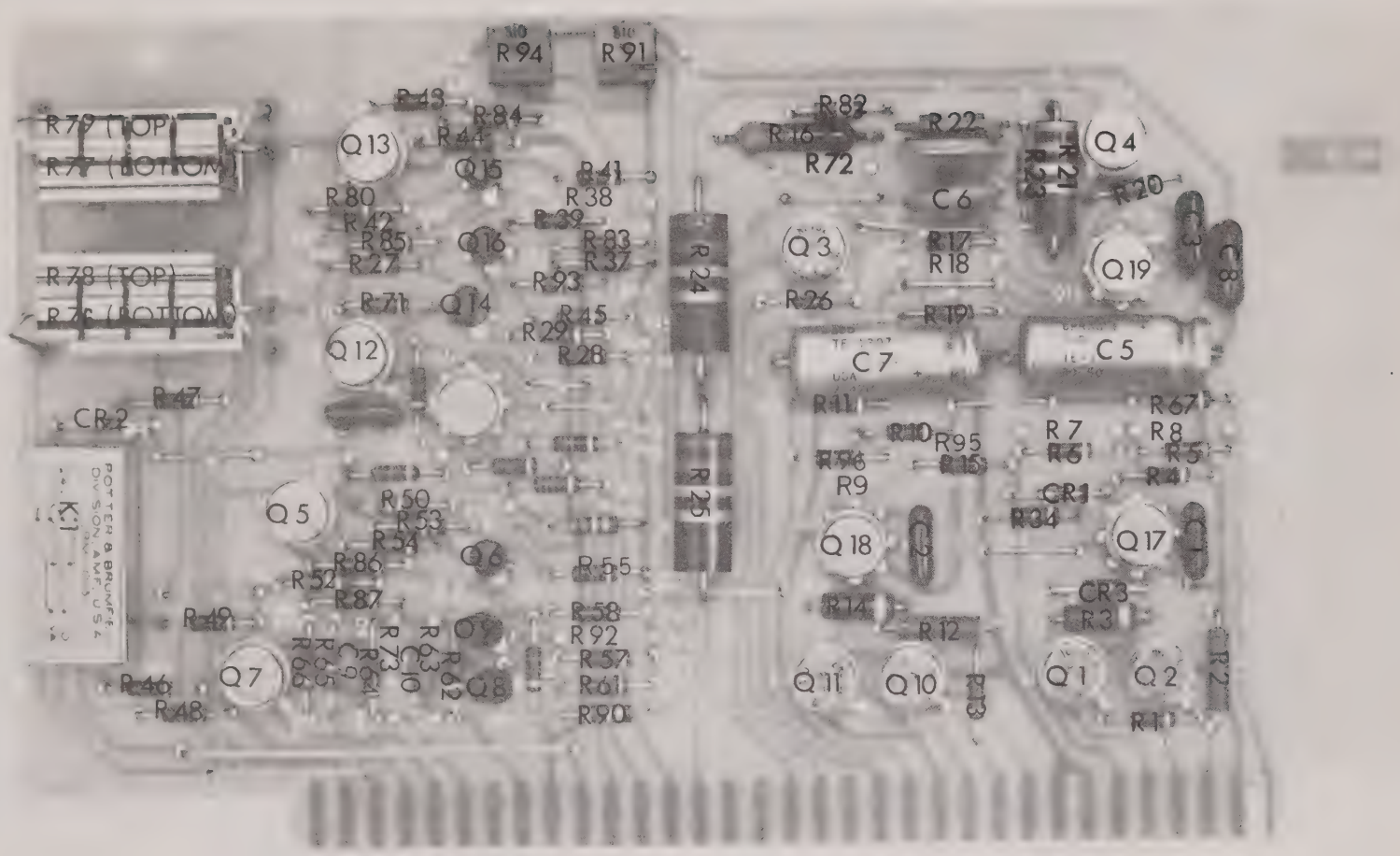


Figure 6.3 A3 P.C. Board Assembly Electronic Parts Location

A3 P.C. BOARD ASSEMBLY ELECTRONIC PARTS LIST

REF.	DESCRIPTION	PART NO.
A3	P.C. BOARD	936146
C1 - C3	CAPACITOR, Mica, 33 pF, 500 V	155472
C5, C7	CAPACITOR, Electrolytic, 50 μF, 50 V	152410
C6	CAPACITOR, Ceramic, .01 μF, 1 kV	150101
C8	CAPACITOR, Mica, 470 pF, 500 V	155515
C9	CAPACITOR, Ceramic, NPO, 3.3 pF, 1 kV	150527
C10	CAPACITOR, Ceramic, NPO, 2.2 pF, 1 kV	150526
CR1	DIODE, Zener, 6.2 V, 1N827 (International Rectifier Corp.)	480011
CR2	DIODE, Silicon, 1N4446	480004
CR3	DIODE, Zener, 5.6 V, 1N4734A (Dickson)	480005
K1	RELAY, DPST, 24 VDC (Potter & Brumfield JRM 1013)	450005
Q1 - Q3 Q10, Q11	TRANSISTOR, NPN Silicon, 2N2102 (R.C.A.)	485004
Q4	TRANSISTOR, NPN Silicon, 2N3440 (R.C.A.)	485007
Q5, Q7, Q12, Q13	TRANSISTOR, NPN Silicon, 2N3439 (Motorola)	485057
Q6, Q8, Q9, Q14 - Q16	TRANSISTOR, NPN Silicon, 2N3391 (General Electric)	485006
Q17 - Q19	INTEGRATED CIRCUIT, Op Amp, LM301A (National)	480655
R1, R13	RESISTOR, Metal Film, 100 Ω ± 2%, 1/4 W	471408
R2, R12	RESISTOR, Wirewound, 0.5 Ω ± 3%, 1 W	477000
R3, R14	RESISTOR, Metal Film, 2200 Ω ± 2%, 1/2 W	472223
R4, R6	RESISTOR, Metal Film, 1800 Ω ± 2%, 1/4 W	471438
R5, R9, R10	RESISTOR, Metal Film, 2400 Ω ± 2%, 1/4 W	471441
R11, R34, R67	RESISTOR, Metal Film, 1 Ω ± 2%, 1/8 W	470670
R15	RESISTOR, Metal Film, 1200 Ω ± 2%, 1/4 W	471434
R16	RESISTOR, Metal Film, 274 kΩ ± 1%, 1/2 W	470661
R17, R48, R49, R87	RESISTOR, Metal Film, 12 kΩ ± 2%, 1/4 W	471458
R19, R20, R54, R55, R61, R66, R71, R80	RESISTOR, Metal Film, 10 kΩ ± 2%, 1/4 W	471456
R21	RESISTOR, Carbon, 330 kΩ ± 10%, 1 W	475887
R22	RESISTOR, Variable, 500 kΩ (Astigmatism Adjust)	479530
R23	RESISTOR, Carbon, 330 kΩ ± 10%, 1/4 W	475657
R24, R25	RESISTOR, Carbon, 18 kΩ ± 10%, 2 W	475939
R26	RESISTOR, Metal Film, 15 Ω ± 5%, 1/8 W	470702
R27, R42-R44	RESISTOR, Carbon, 1 MΩ ± 10%, 1/4 W	475678
R28	RESISTOR, Metal Film, 24 kΩ ± 2%, 1/4 W	471465
R29	RESISTOR, Metal Film, 47 kΩ ± 2%, 1/4 W	471472
R64	RESISTOR, Metal Film, 51 kΩ ±2%, 1/4W	471473
R64 (Opt. M1)	RESISTOR, Metal Film, 100 kΩ ±2%, 1/4W	471480

A3 P.C. BOARD ASSEMBLY ELECTRONIC PARTS LIST (CONT'D)

REF.	DESCRIPTION	PART NO.
R37	RESISTOR, Metal Film, 910 Ω ±2%, 1/4W	471431
R38, R39, R58	RESISTOR, Metal Film, 1000 Ω ±2%, 1/4W	471432
R41	RESISTOR, Metal Film, 11 kΩ ±2%, 1/4W	471457
R45	RESISTOR, Metal Film, 13 kΩ ±2%, 1/4W	471459
R46, R47	RESISTOR, Metal Film, 56 kΩ ±2%, 1/4W	471474
R50, R52, R53, R65	RESISTOR, Carbon, 820 kΩ ±10%, 1/4W	475677
R57	RESISTOR, Metal Film, 1100 Ω ±2%, 1/4W	471433
R59	RESISTOR, Metal Film, 1300 Ω ±2%, 1/4W	471435
R62	RESISTOR, Metal Film, 100 kΩ ±2%, 1/4W	471480
R62 (Option M1)	RESISTOR, Metal Film, 150 kΩ ±2%, 1/4W	471484
R76, R77	RESISTOR, Wirewound, 39 kΩ ±1%, 5W	477160
R78, R79	RESISTOR, Wirewound, 33 kΩ ±1%, 5W	477159
R82	RESISTOR, Carbon, 180 kΩ ±10%, 1/4W	475650
R84 - R86	RESISTOR, Metal Film, 15 kΩ ±2%, 1/4W	471460
R90, R93	RESISTOR, Carbon, 470 kΩ ±10%, 1/4W	475661
R91, R94	RESISTOR Variable, 5 kΩ (H and V Balance)	479517
R7, R8, R18, R63, R72, R73, R83, R92, R95 R96	RESISTOR, Value Determined at Test	
C3, R30-R33, R35, R36, R40, R51, R56, R60, R68, R69, R70, R74, R75, R81, R89	Reference Designations Not Used	

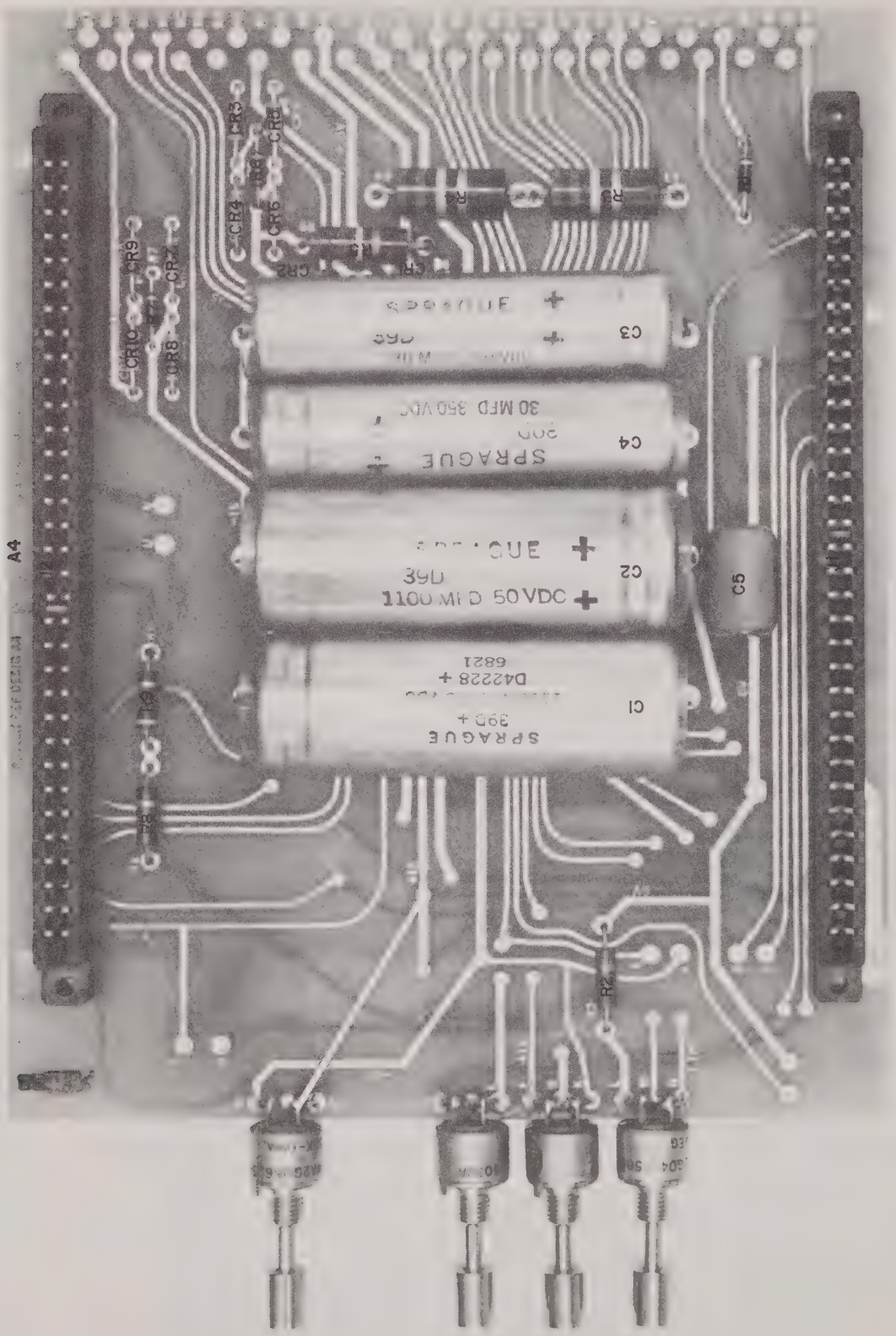


Figure 6.4 A4 P.C. Board Assembly Electronic Parts Location

A4 P.C. BOARD ASSEMBLY ELECTRONIC PARTS LIST

REF.	DESCRIPTION	PART NO.
A4	P.C. BOARD	936149 B
C1, C2	CAPACITOR, Electrolytic, 1100μF, 50 V	152435
C3, C4	CAPACITOR, Electrolytic, 30μF, 350 V	152600
C5	CAPACITOR, Film, 0.1μF, 400 V	157195
CR1, CR2	DIODE, Silicon, 1N4006	480042
CR3-CR10	DIODE, Silicon, 1N4005	480003
J1, J2	CONNECTOR, Receptacle, 33 pin female (AMP 583359-1)	210118
R1	RESISTOR, Fixed Metal Film, 1000Ω, 1/4 W, 2%	471432
R2	RESISTOR, Fixed Composition, 6.8MΩ, 1/2 W, 5%	475280
R3, R4	RESISTOR, Fixed Composition, 18kΩ, 2 W, 10%	475939
R5	RESISTOR, Fixed Composition, 510kΩ, 1 W, 5%	474940
R6, R7	RESISTOR, Fixed Metal Film, 20kΩ, 1/4 W, 2%	471463
R8	RESISTOR, Fixed Composition, 4.7MΩ, 1/2 W, 5%	475785
R9	RESISTOR, Fixed Composition, 1MΩ, 1/2 W, 10%	475779

NON-STRUCTURAL MECHANICAL PARTS LIST

ITEM	USED FOR/ COMMENT	QTY	P/N	MFR & P/N
BAIL, with Front Feet	Bottom Cover	1 set	240027	
BRACKET, Connector	Plug-in Compartment	1	922128	
BRACKET, Resistor	A3 Board	2	922145	
BUSHING, Front Panel		2	934139	
CLIP, Resistor	A3 Board	4	218000	Ohmite 5905
CORNER BLOCK, Front	Without Handles	2	928477	
COUPLING, Shaft		4	960178	
COVER, Bottom		1	916052	
COVER, High Voltage		1	960129	
COVER, Top		1	916051	
FEET, Front, with Bail	Bottom Cover	1 set	240027	
FEET, Rear		2	280009	Budwig F6G
GRATICULE, CRT, 8x10 div		1	960037-1	
GRATICULE, CRT, 10x10 div	Option M1		960037-2	
GRATICULE, CRT, Floures-cent, 8x10 div	Model 9034 Bezel		960037-3	
GRATICULE, CRT, Blank	Special Purpose		960037	
HANDLE, Front	Corner Blocks	2	240028	Novatronix 10235B-0632-4
HEAT DISSIPATOR, TO-5 Transistor		5	480750	IERC TXBF-032-025B
HEAT SINK, Oscillator	A1 Board	1	922179	
HEAT SINK, Transistor	Rear Panel	1	928472	
HEAT SINK, Transistor	Q7	1	922130	
KEY, Polarizing	J1 & J2	2	210156	AMP 583462-1
KNOB, Red	Intensity & Focus	2	960019	
PANEL, Front	Panel Overlay	1	915036	
PANEL, Rear		1	916048	
PLUG, Hole, 3/4"	Remote Input	1	280225	Heyco P687
SHAFT, Plain	Intensity & Focus	2	934137	
SHAFT, Slotted	Horiz Gain & Pos	2	934138	
SHIELD, CRT		1	960096	
SPACER, Press-Fit	A1 & A3 Boards	4	280023	Sealectro 227258